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# FROM BIOECONOMICS TO BIOECONOPHYSICS

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**Abstract.** *This interdisciplinary approach of the economy changes its classical concept for reasons connected with the need to extend the biology laws in the economic reality, but also to replace the outdated view of the classical and unsystematic economic theory, in the view of the external environment, limited resources and the coexistence of man with other species, in a limited habitation. Econophysics is another interdisciplinary approach to economics and physics, yet focused on improving the model of investigation by capitalizing on the realism of physics models in the subject of study of the economy and by improving it from the instrumental and experimental point of view. Bioeconophysics seems to be not a compromise but a first real attempt of the economic reality by valorizing the laws of biology and the models of econophysics.*

**Keywords:** *bioeconomics, bioeconophysics, bioeconomy, trans-, inter-, and multidisciplinary.*

## 1. INTRODUCTION

Among the most important economic school of the 20<sup>th</sup> century one can find Bioeconomics, a transdisciplinary science placed alphabetically between Austrian school and the Chicago school, in a long list together with constitutional economics, evolutionary economics, econophysics school, Freiburg school, Freiwirtschaft, Georgism school, institutional economics, Keynesian economics, Marxian (Marxist) and neo-Marxian economics, Neo-Ricardianism, New classical macroeconomics, New Keynesian and Post-Keynesian economics, public choice school, Lausanne school, sociophysics school, Stockholm school, etc.

As a new concept, *Bioeconomics* was used for the first time by British biologist Hermann Reinheimer, in 1913, in his paper entitled *Evolution by Co-operation: A Study in Bioeconomics*, and today we can find four usual significations [1]:

A. Studying the dynamics of living resources using economic models (Fisheries)

B. Economic systems based on the laws of thermodynamics (Biophysical)

C. Study of the relationship between human biology and economics (Biological economics)

D. Social theory of Nicholas Georgescu – Roegen (Bioeconomics) [2].

One of the most important and recognized mathematician, statistician, demographer and biologists in USA, during the first half of the 20<sup>th</sup> century, Alfred James Lotka (1880-1949) was the first theoretician of the new science, based on his opinion about population described as an aggregate with renewal processes, and especially based on his reputation and knowledge. In fact, Lotka defined Bioeconomics or Biophysical economics as a profound correlation between the

biological laws and the thermodynamic laws inside the permanent competition for energy and material resources [3].

But the real father of the Bioeconomics was Nicholas Georgescu-Roegen (1906-1994), a well known Romanian-born and finally American statistician, mathematician, economist and bioeconomist, the major author of the interpretation of economics through the new paradigm of the so-called Bioeconomics. His essential conception and his defining manner are based on physics turned entropy into Bioeconomics [4, 5].

The new paradigm of bioeconomics is still difficult to define, especially because some ambiguities developed during the last decades. Thus, the modern economist can find three important sets of questions that need answers:

Bioeconomy or Bioeconomics? Is Bioeconomics different from bioeconomy? Are these terms synonymous? Bioeconomy defines a set of specific economic activities and political projects, while bioeconomics has numerous different important significances: a) a study of how organisms of all kinds earn their living in nature's economy (Reinheimer, 1913); b) a relationship holding between the biological laws of evolution and the laws of thermodynamics (Lotka, 1925); c) a research paradigm [6] combining two independent, though in many respects related, scientific disciplines: economics and biology (Witt, 1999); d) a specific type of economy [7] where the basic building blocks for materials, chemicals and energy are derived from renewable biological resources (McCormick & Kautto, 2013).

What does Bioeconomics mean for his originator Nicholas Georgescu-Roegen, as a different type of economics? Which is the most important aspect in Bioeconomics? In Nicholas Georgescu-Roegen's research approach, or scientific vision Bioeconomics became: i) a real solution to unavoidable ecological disasters that would make the survival of the human species the shortest of all on this globe; ii) a combination including evolution of biology, economics and thermodynamics; iii) an approach to the economic process seen as an extension of biologic evolution (human ability, and ultimately the capacity of the species, of developing tools and generating detachable organs, or extensions of the human body, redefined as exosomatic organs, which becomes a biologic component of bioeconomics); iv) a physical view (econophysics) does exist at the very start of bioeconomics as incapacity of classic economics to understand and recognize the economic process of cumulative (irreversible) change, caused by the mechanist dogma.

## 2. THE ECONOMIC PROCESS AS AN ENTROPIC PROCESS

The economic process was, is, and will still be, an entropic process in Bioeconomics, where four postulates are essential in Nicholas Georgescu-Roegen's view:

I. The qualitative changes caused by the extensions of the human body contributed to the stagnation of the progress of classical (mechanist) economics, the degradation of the environment by man and the human race, destroying the economic process.

II. There is an irreducible, permanent opposition between the economic process in the mechanist and thermodynamic views: the entropy of a closed economic system continually and irreversibly rises to a maximum value, the energy available being transformed into unavailable energy, until it disappears. Modern Malthusianism (the Bartle law): exponential economic growth is correlated with the increasing penury of resources. There is no absolute substitutability.

III. Starting from thermodynamics and the second axiom, the idea emerges that matter is subject to the same degradation as energy is (the example of irretrievable rubber, of plastic, etc.)

IV. Not even the most efficient recycling system will be able to stop the degradation of resources! This is how entropy works today in contemporary bioeconomics!

The seven findings or derived principles of bioeconomics remain the following objectives from Nicholas Georgescu-Roegen work [8, 9]:

1. The technological optimism of classical economics is absolutely unreasonable and groundless.

2. Production implies the transformation of a limited stock of raw materials and energy, and is in accordance with the laws of the economy. Economic growth is only an apparent increase in the ratio of outputs per inputs, and a genuine entropic degradation of the resources and energy.

3. The Earth has limited resources and energy, and is not the property of a given generation.

4. The principle of the conservation of resources and energy is fundamental.

5. The excesses of classical consumerism must be deterred, the resources should be made global, which includes *human resources, who should no longer possess a passport* (Georgescu-Roegen).

6. Policies based on bioeconomics imply no risk, since the economic process is irreversible.

7. Restricting life focused on exosomatic comfort, which is short and tumultuous, and the expansion of a lifestyle that seems to be more monotonous, and yet longer.

The excessively structured and monopolized economic process has an ever higher entropy. Entropy can also change a classical economic program into a bioeconomic one that looks like Nicholas Georgescu-Roegen's program described by Nicholas Wade in *Penthouse, not in a cave* [4] in only three common points:

- a) diminishing weapon production to total disappearance;
- b) diminishing population to the level of food ensured by organic farming;
- c) consumption for consumption's sake, or trendy consumption should be seen as a type of bioeconomic crime legally punished (e.g. changing one's car yearly).

### 3. BIOECONOPHYSICS/ECONOBIOPHYSICS

Biology, Physics and Economics together mean in the last two decades not only classical Bioeconomics but much more, Bioeconophysics, as a new science, including their specific models or bioeconophysics models. The first model of the classical bioeconomics was rather a descriptive one (Lotka-

Volterra model), but the new models of bioeconophysics are more efficient (e.g. the econophysics and sociophysics models). Biophysical Economics or Ecological Economics are, in different contexts, somehow similar to Econobiophysics or Bioeconophysics.

The economic process consists in the continuous transformation of low entropy into high entropy and thus Biology and Physics are apparently in a state of permanent confrontation, and the autonomy of classical economics is an illusion. Physics exerts isolation through experiment, while biology emphasizes the importance of nullification of isolation, or laying stress on the outer milieu. Economic systems cannot be taxonomized in detail in a biologic manner, starting from individuals to the species, etc. even some trends in experimental economics constantly try to do this complete taxonomy.

Bioeconophysics has characteristic conceptual dualities [10, 11, 12]. In thermodynamics there are two essential variables: temperature and pressure. By making use of temperature and pressure, the two laws of thermodynamics are determined. Economic theory also focuses on two parameters: capital and labour. Accountancy leads to equations that correspond to the laws of thermodynamics. Capital and temperature, labour and pressure, surplus/deficit and heat/loss of heat, the production function and entropy, the living standards and energy, become similar concepts or conceptual dualities through the similarity of economic and thermodynamic theory. Biology is also a natural science, whose theory also centres on two parameters: living plants and animals, which are assimilated to heat and entropy. Living plants and animals are the same thing as heat, while the DNA becomes entropy. Photosynthesis is a Carnot production process, etc.

A new theory is not necessary in order to delimit the full understanding of bioeconophysics, but only a reinterpretation specific to trans-, inter- and multidisciplinary researches.

### 4. CONCLUSIONS

The new science of bioeconomics considers that some patterns of biological evolution can be applied in the economic behavior of consumers, producers, the market, etc., as many of the same causal interactions and survival elements are found there as well as in nature (e.g. a theory of homogeneous middleman groups as adaptive units, the bioeconomics of cooperation, etc.) In biology, groups of organisms coexist together to make the best use of resources and to live together, while promoting the survival of the fittest.

Bioeconomics is not the science of behavioral finance, but it represents another example of economic theory that differentiates itself from the boundaries of classical economics, and tries to better explain the complexity of economics in the present time.

Bioeconophysics expressly recognizes the quality of the physical models applied in bioeconomics and their high degree of clarity and prognosis.

The new civilizations are trying to create a wholly new world order. Policies and predictions, even global, will fail if they are incompatible with the universal economic reality. Only used together will competition and cooperation be useful for the success of adaptation and innovation. Information, or modern knowledge in an economy, does not replace energy, and energy use is unlikely to diminish.

Production resources should not be sacrificed by trade, and subsidies removed to achieve greater economic efficiency.

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# CASE STUDIES OF UTILIZATION OF THE MIND MONITORING SYSTEM (MIMOSYS) USING VOICE AND ITS FUTURE PROSPECTS

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**Abstract:** *We developed a method to measure the mental health condition of speakers based on the emotional components contained in the voice; we named the method Mind Monitoring System (MIMOSYS). Voice is input into MIMOSYS, and MIMOSYS outputs two vocal indices: vitality, a short-term index, and mental activity, which is calculated from the long-term tendency of vitality.*

*In this article, we first present an overview of MIMOSYS. We then present a development case of a smartphone app that utilizes MIMOSYS. Following this, we present case studies in which MIMOSYS vocal indices were used. The first study is on the relation of vitality and mental activity with the Beck Depression Inventory, a questionnaire index widely used for diagnosing depression. The second study is on the relation of vitality with Brain-Derived Neurotrophic Factor, blood indices, and the General Health Questionnaire 30 (GHQ30), a questionnaire index regarding neurosis. These studies demonstrated that the vocal indices of MIMOSYS exhibit identification tendencies similar to those of questionnaire indices and blood indices.*

**Keywords:** *Mind Monitoring System (MIMOSYS), Mental healthcare, telemonitoring, Beck Depression Inventory (BDI), Brain-Derived Neurotrophic Factor (BDNF), General Health Questionnaire (GHQ)*

PACS numbers: 89.65.Gh, 89.75.Fb, 05.45.Tp

## 1. INTRODUCTION

In modern society, economic losses caused by the mental health disorders that individuals experience have become an international issue, and there is a call for appropriate measures [1] [2]. In order to address this issue, a mental health screening method that can be used on a daily basis at a low cost is necessary. Currently, the main means of assessing mental health include medical interviews by professionals such as physicians and self-administered questionnaires such as the General Health Questionnaire (GHQ) [3] and Beck Depression Inventory (BDI) [4]. However, there is a limit on the number of medical interviews that can be conducted by professionals, and reporting bias is an issue with self-administered questionnaires. Here, reporting bias indicates the selective concealment or exposure by the subject, of specific information such as medical history or smoking history. Moreover, although assessment using biomarkers such as saliva and blood has been studied [5][6], the issues of costs and burden on the subjects remain.

On the other hand, pathophysiology analysis using vocal data is drawing attention with the recent spread of

smartphones [7]. Its non-invasive nature, in addition to the fact that it can be conveniently conducted remotely, as it does not require a dedicated device, is an advantage of voice analysis using smartphones. From this point of view, the authors have been engaged in the development of a method that estimates stress conditions and depression based on vocal data [8] [9].

Specifically, as stress exerts an impact on humans' emotions [10], we developed a method to measure the mental health of a speaker based on the variations in emotional components extracted from the voice rather than directly analyzing stress conditions based on vocal data; we named it Mind Monitoring System (MIMOSYS) [9]. Voice is input into MIMOSYS, and MIMOSYS outputs two vocal indices of vitality – a short-term index, and mental activity, which is calculated from the long-term tendency of vitality.

In this article, we first present an overview of MIMOSYS. We then present a development case of a smartphone app that uses MIMOSYS. Following this, we present case studies in which MIMOSYS vocal indices were used. Finally, we describe the future prospects.

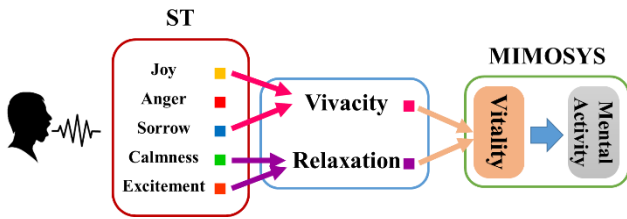
## 2. OVERVIEW OF THE MIND MONITORING SYSTEM (MIMOSYS)

In this chapter, we present an overview of the algorithm of MIMOSYS [9]. MIMOSYS is a system that measures the mental health condition of a person based on voice. For example, with regard to Major Depressive Episodes, the DSM-V lists characteristics such as loss of interest or pleasure and continued depressed mood, in which one experiences sadness and emptiness. Conversely, a higher proportion of the pleasure component than that of sadness in emotions can be considered as an indication of reasonable mental condition. From these perspectives, MIMOSYS estimates the mental health condition of a speaker based on the balance and variations in the emotional components in the speaker's voice.

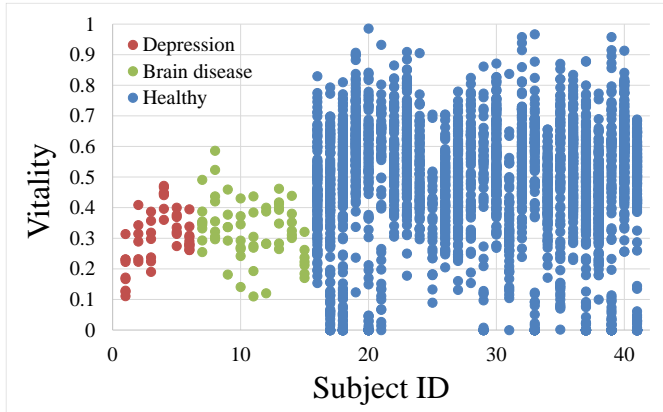
MIMOSYS first calculates the degree of intensity of each of the four emotional components (“calmness,” “anger,” “joy,” and “sorrow”) in voiced speech on eleven-point scale of zero to ten using Sensibility Technology Ver.3.0 (AGI Inc., Tokyo, Japan), a vocal emotion recognition technology [11-13]. It also calculates the intensity of “excitement” on a ten-point scale of one to ten.

Next, based on the intensity of these five indices, vivacity and relaxation are calculated. It is noteworthy that vivacity is calculated from the joy and sorrow components, while relaxation is calculated from the calmness and excitement

components. Finally, vitality is calculated from vivacity and relaxation.



**Fig. 1** Data calculation flow of MIMOSYS. (Adapted from reference [14])



**Fig. 2** Example of vitality measurement. The horizontal axis represents subject ID, and the vertical axis represents vitality. The subjects are ordered from left to right as follows: patients with depression; brain disease patients with cerebral infarction, intracerebral hemorrhage, etc.; and healthy subjects. The data are arranged vertically because separate measurements of each subject were collected. (Adapted from reference [15])

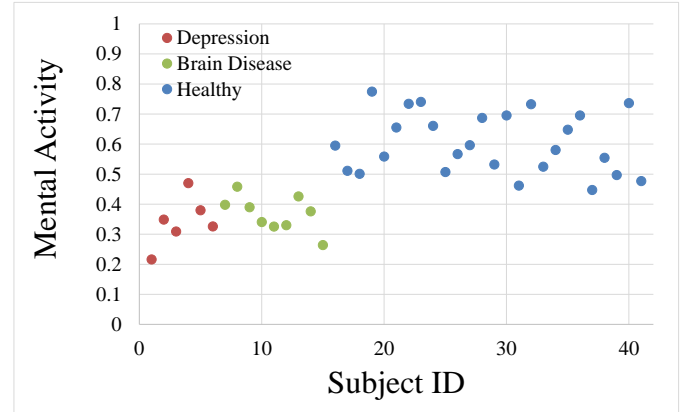
In general, “vitality” can be defined in variously and can imply various concepts. However, here, vitality can be briefly defined as a scale on which patients experiencing depression or cerebral infarction score low, while healthy individuals score high. MIMOSYS calculates mental activity in addition to vitality as an index of mental health. These indices are output as real values in the interval [0.0, 1.0].

The main dissimilarity between vitality and mental activity is the duration of the measurement period. Vitality estimates the degree of mental health based on emotional components (“calmness,” “anger,” “joy,” and “sorrow”) as well as “excitement” contained in short-term vocal data such as a phone call.

On the other hand, mental activity is calculated based on data of vitality accumulated over a certain period of time, such as two weeks. Vitality varies depending on the circumstances at the time of measurement in a manner similar to variations in blood pressure while at rest immediately after exercise. We aim for a more accurate assessment of mental health by introducing mental activity in a manner similar to enhancing accuracy of determination of hypertension through long-term monitoring of blood pressure. Figure 1 illustrates the calculation flow.

Moreover, Figs. 2 and 3 illustrate measurement examples of the vitality and mental activity of 26 healthy subjects and 15 patients (six patients with depression and nine cerebral infarction patients). Here, the horizontal axis represents

subject ID, and the vertical axis represents the respective index values (vitality and mental activity). The subjects are ordered from left to right as follows: patients with depression; brain disease patients with cerebral infarction, intracerebral hemorrhage, etc.; and healthy subjects. It is noteworthy that in Fig. 2, because separate measurements of each subject were collected, the data for vitality are arranged vertically.



**Fig. 3** Example of mental activity measurement. The horizontal axis represents subject ID, and the vertical axis represents mental activity. The subjects are ordered from left to right as follows: patients with depression; brain disease patients with cerebral infarction, intracerebral hemorrhage, etc.; and healthy subjects. (Adapted from reference [15])

**Table 1** Identification performance of MIMOSYS with respect to healthy subjects and patients (depression and brain disease)

Index	AUC	Sensitivity	Specificity
Vitality	0.80	0.94	0.64
Mental Activity	0.99	1.0	0.92

We present the Area under the Curve (AUC) as well as the sensitivity and specificity against the Receiver Operating Characteristic (ROC). Regarding vitality, AUC was 0.80, while sensitivity and specificity were 0.94 and 0.64, respectively. Meanwhile, regarding mental activity, AUC was 0.99, while sensitivity and specificity were 1.0 and 0.92, respectively. It has, thus, been demonstrated that mental activity, which is a long-term index, enhances identification performance. In particular, enhancement in specificity is significant.

### 3. IMPLEMENTATION OF MIMOSYS AS A SMARTPHONE APP

In this chapter, we present a development case of a smartphone app that uses MIMOSYS. We took note of telephone calls in which we routinely speak out loud and implemented MIMOSYS as a smartphone app [16].

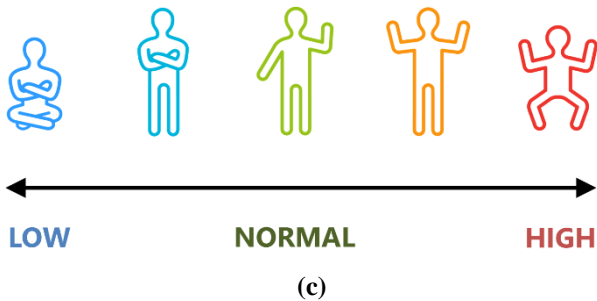
This system consists of the following processes:

1. Audio recording
2. Analysis of health condition based on recorded voice
3. Accumulation of analysis results
4. Deletion of audio used for analysis
5. Presentation of accumulated analysis results to the user



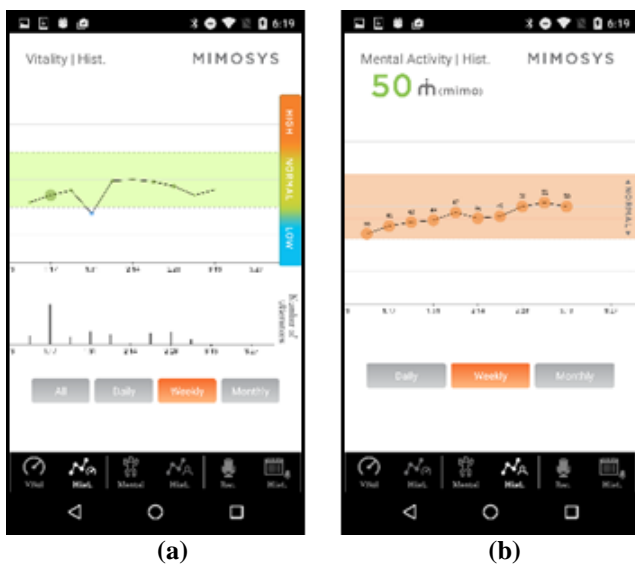


(a) (b)



(c)

**Fig. 4** Examples of the smartphone app’s display of analysis results: (a) vitality, (b) mental activity, and (c) human-type animation representing mental activity. (Adapted from reference [16])



(a) (b)

**Fig. 5** Examples of the smartphone app’s display of the history of analysis results: (a)vitality and (b)mental activity. (Adapted from reference [16])

Figure 4(a) {vitality}, Fig. 4(b) {mental activity}, Fig. 5(a) {history of vitality}, and Fig. 5(b) {history of mental

activity} are illustrated as examples of display of analysis results by this app.

In the smartphone app, both vitality and mental activity are converted from real values within [0.0, 1.0] to integer values within [0,100].

As illustrated in Figs. 4(b) and (c), mental activity is displayed on a five-point scale using human-type animation, according to the mental activity level. Moreover, as illustrated in Fig. 5, history of both vitality and mental activity are displayed on line charts.

Currently, a large-scale demonstration experiment is being conducted using this smartphone app [17].

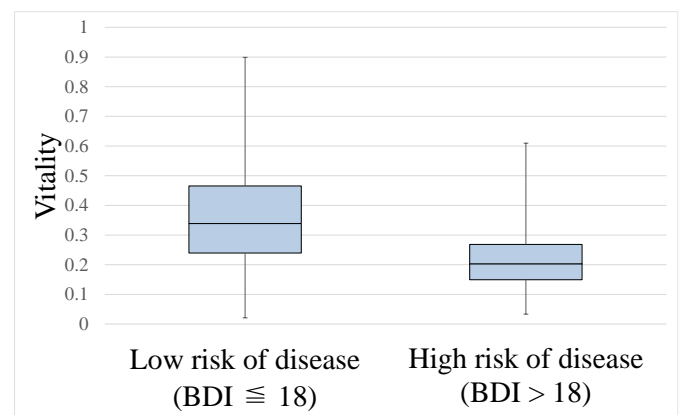
#### 4. BDI AND MIMOSYS INDICES (VITALITY AND MENTAL ACTIVITY)

In this chapter, we present a study [14] on the relation between the BDI, which is widely used for diagnosing depression, and MIMOSYS vocal indices (vitality and mental activity).

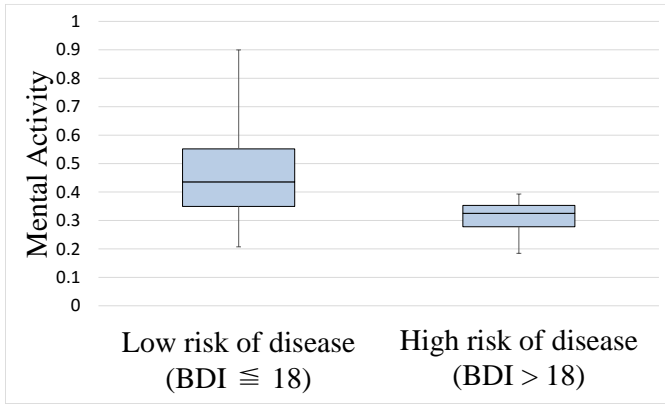
As part of this study, we collected audio data from 50 subjects (39 males and 11 females) over a period of approximately 2 months using the MIMOSYS smartphone app, which we described in the previous chapter. We also conducted the BDI test at the time when audio acquisition was started. However, because BDI scores are likely to vary in the medium- to long-term, at the time of analysis, we used audio data from the two weeks since the BDI test was performed. Of the data on 50 subjects, those on 48 subjects were valid for analysis.

First, based on the BDI scores, the subjects were divided – according to reference [18] – into two groups: the “low risk of disease” group with a score of 18 or less and the “high risk of disease” group with a score higher than 18. There were forty-three subjects in the low risk of disease group and five in the high risk of disease group.

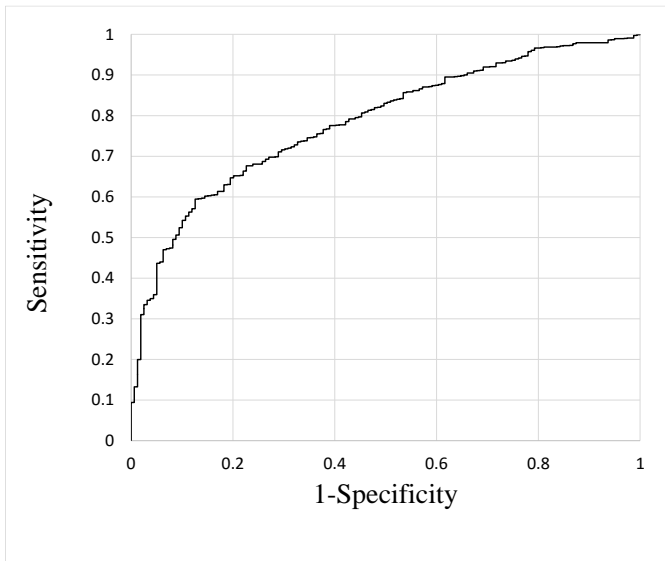
Figure 6 illustrates the vitality of the two groups. The average values of vitality for the low risk of disease group and high risk of disease group were 0.37 (SD = 0.17, N = 1221) and 0.21 (SD = 0.094, N = 159), respectively. The results of the t-test demonstrated a significant difference between the two groups ( $t(307) = 16.89, p = 1.03E-46$ ).



**Fig. 6** Box and whisker plots of vitality score by fixed phrase for the low risk of disease and high risk of disease groups. (Adapted from reference [14])



**Fig. 7** Box and whisker plots of mental activity score by fixed phrase for the low risk of disease and high risk of disease groups. (Adapted from reference [14])



**Fig. 8** ROC curve used in discriminating between low and high risk of disease using vitality index. (Adapted from reference [14])

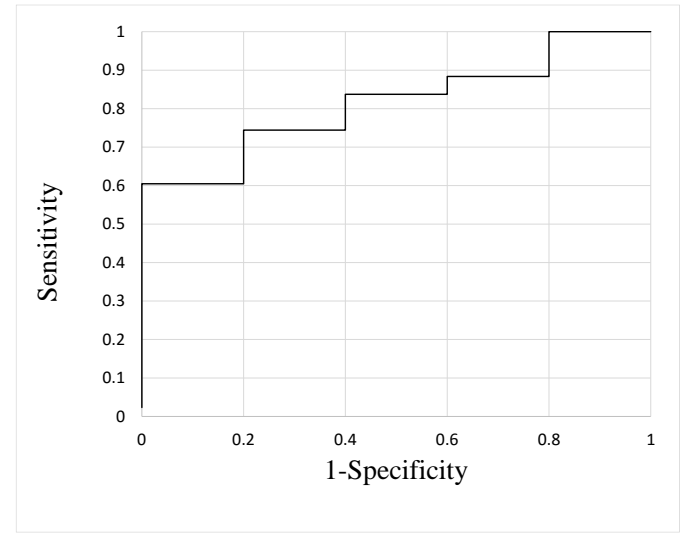
**Table 2** Identification performance of MIMOSYS regarding low risk of disease group and high risk of disease group.

Index	AUC	Sensitivity	Specificity
Vitality	0.78	0.80	0.64
Mental Activity	0.81	1.0	0.61

Further, we illustrate the mental activity of the two groups in Fig. 7. The average values of mental activity for the low risk of disease group and high risk of disease group were 0.46 (SD = 0.15, N = 43) and 0.31 (SD = 0.08, N = 5), respectively. The results of the t-test demonstrated a significant difference between the two groups ( $t(8) = -3.6, p = 0.007$ ).

We present the AUC, sensitivity, and specificity of the ROC curve in Table 2 to determine the identification performance with regard to vitality and mental activity for the low risk of disease group and high risk of disease group. The AUC of vitality was 0.78, and the sensitivity and specificity were 0.80 and 0.64, respectively. Meanwhile, the AUC of mental activity was 0.81, and the sensitivity and specificity were 1.0 and 0.61,

respectively. Figures 8 and 9 reveal the ROC curve of vitality and mental activity.



**Fig. 9** ROC curve used in discriminating between low and high risk of disease using mental activity index. (Adapted from reference [14])

Thus, the AUCs of vitality and mental activity were both approximately 0.8 indicating reasonable identification performance.

## 5. MIMOSYS, BLOOD INDICES, AND QUESTIONNAIRE INDICES

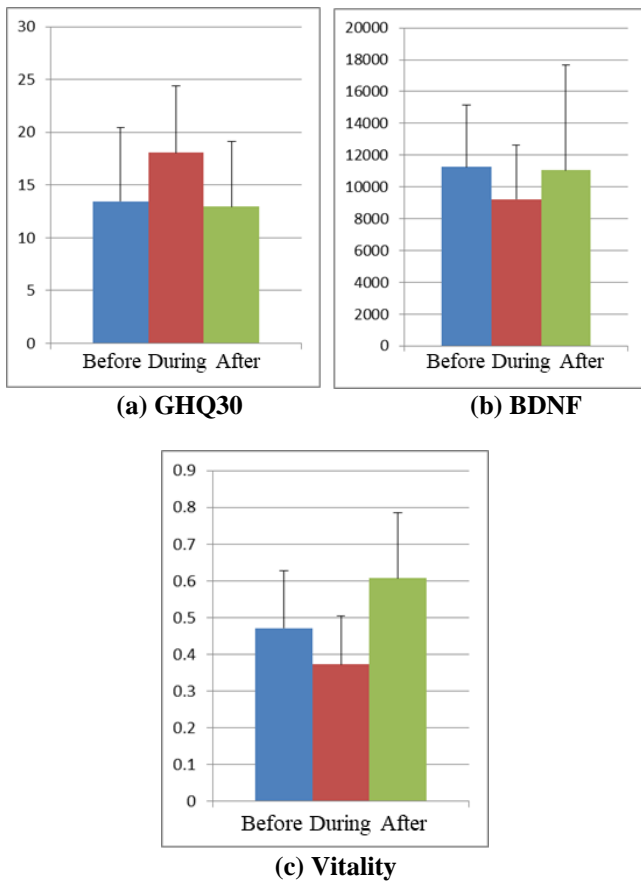
It is known that subjects with depression or those that are under stress exhibit decreased blood Brain Derived Neurotrophic Factor (BDNF) concentrations [19]. Similar to the BDI, the GHQ-30 is also a self-administered questionnaire that has been widely used for diagnosing depression.

In this chapter, we present studies [19] [20] on the relation of these two indices, that is, BDNF, a blood index, and the GHQ-30, a questionnaire index, with vitality, a vocal index.

In this study, the subjects were the members of the Self-Defense Force airborne brigade at the time of a ranger training program during which they were under extreme stress. The training was carried out over a period of nine weeks. Blood collection, audio recording and a self-administered questionnaire were performed three times, once each before, during (three weeks into the training program) and after (three to five days after the training program had ended) the training program.

Figure 10 presents the values of (a) the self-administered questionnaire GHQ-30, (b) blood index BDNF, and (c) vocal index “vitality” before, during, and after the Self-Defense Force ranger training program. The data before, during, and after the training program are ordered from left to right in each figure. Here, it should be noted that the higher the GHQ-30 scores, the higher the stress or depression tendency. On the other hand, the lower the vitality and BDNF, the higher the stress or depression tendency. In effect, the GHQ-30 is an index with a magnitude relation that is in reverse to the other two.

The figures indicate a similar tendency in which each index exhibits the highest stress levels during training.



**Fig. 10** Comparison of the results of (a) the self-administered questionnaire GHQ-30, (b) blood index BDNF, and (c) vocal index “vitality” before, during, and after the Self-Defense Force ranger training program. (Adapted from the reference [20])

## 6. SUMMARY AND FUTURE PROSPECTS

In this article, we presented an overview and a few research and development cases of MIMOSYS. MIMOYS is likely to be capable of distinguishing between patients with depression and brain disease from healthy individuals based solely on voice, with high accuracy. Moreover, it is likely that it will serve as an alternative to other indices that measure the degree of stress and depression. For example, blood index BDNF or questionnaire indices such as the BDI and GHQ-30 screening solely based on voice is superior to blood tests in terms of costs and the burden on the subjects; moreover, it overcomes the issue of reporting bias that is present in self-administered questionnaires. Implementation of MIMOSYS as a smartphone app to analyze voice calls permits us to monitor daily mental health condition, which can result in early detection of depression, etc.

Currently, we are working on applying the MIMOSYS technology to field of the occupational medicine [21] and the development of automobiles [22]. With respect to application in the industrial hygiene field, we are developing a system that can result in the introduction of intervention at the appropriate time using self-administered questionnaires and a stress

resilience program, as we monitor the stress levels of the employees of IT companies by MIMOSYS [21]. In addition, regarding application to the development of automobiles, in the past, the effects of driving a car have mostly been studied in light of negative aspects such as fatigue and drowsiness. Instead, we focus on positive aspects such as altering the mood to work on an application for developing a comfortable and safe automobile [22].

Furthermore, we are working on applying speech pathology analysis to depression and stress as well as to other diseases. Vitality and mental activity measured by MIMOSYS are imprecise indices to categorize healthy individuals and patients with depression or brain disease, and they are not suitable for detailed differentiation of diseases. Therefore, we are conducting research on its use for the differential diagnosis of a number of diseases and monitoring the course of diseases by directly extracting characteristic values unique to the diseases from voice without applying a vocal emotion recognition technology. In addition to mental disorders such as depression and bipolar disorder, we are currently conducting research on diseases and disorders that are likely to cause variation in the voice, such as neurological disorders (Parkinson’s disease, etc.), dementia (including Alzheimer’s disease), and dysarthria (vocal cord polyps, etc.).

Currently, feature values that are likely to enable us to distinguish patients with Parkinson’s disease from healthy individuals [23, 24] and feature values that enable us to identify severity of depression [25], etc. have been recommended. In the future, we aim to develop a system that enables the differentiation of Parkinson’s disease, dementia, and depression.

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# MEASUREMENT OF STRESS LEVEL TO PREVENT POST-TRAUMATIC STRESS DISORDER DEVELOPED BY IDENTIFYING DEAD BODIES

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**Abstract.** *Mental health issues in individuals who interact with dead bodies during a disaster have been issue of interest. Therefore, there is increased demand for technologies that enable simple and easy-to-perform stress checks. The authors have been pursuing research on technologies that can be used to estimate an individual's mental state based on voice. Analyses of voice have the benefits of being non-invasive and simple to perform. In the present study, we investigated the usefulness of stress measurements using voice in Identification Workshop of Dead Bodies. The participants comprised dentists and other concerned individuals. Participants who underwent training using a mannequin prior to training with an actual body tended to have more similar mental states before and after the body training than those with no mannequin training before the body training. Although the differences we observed were not statistically significant, we do believe that prior training with a mannequin did have an effect on the mental state before and after the body training. Our results suggest that mannequin training may induce increased stress resistance during the body training. We thus believe that stress evaluations using voice analysis are efficacious, easy-to-use, and can be performed even during the limited amount of time set aside for training. We also believe that this technology can be used at actual disaster-response sites.*

**Keywords:** *mental health care, voice analysis, body-related work*

PACS numbers: 89.65.Gh, 89.75.Fb, and 05.45.Tp

## 1. INTRODUCTION

Work involving dead bodies at medical sites following disasters is extremely stressful. At times, this work can even be detrimental to health and lead to post-traumatic stress disorder and other issues [1, 2]. Identification of bodies, which is a task involving corpses, requires the collection of dental information from dead bodies, comparing this information with pre-death dental treatment records, and confirming the identity of the body. Dentists are often asked to participate in the coroner's inquest and to perform post-mortem examinations. Regular meetings of "identification workshop" including dentists and other physicians are held [3]. In these groups, mannequins or actual corpses are used in training drills for large-scale disasters involving numerous dead bodies. In their daily work, dentists almost never encounter a corpse, and while exposure to stress is expected in this type of training, measurements of

the effects of such training and related stress levels are almost never made.

Self-administered psychological tests are generally used to assess stress and depression. These assessment tools include the General Health Questionnaire [4] and Beck Depression Inventory [5]. While such tests are non-invasive and relatively easy to perform, the effects of reporting bias cannot be excluded when using these tests. Reporting bias occurs when specific information is, either consciously or unconsciously, selectively underestimated or exaggerated [6]. Evaluations of mental states using biomarkers such as saliva [7] or blood [8] have been proposed, yet biomarker evaluations are still under development. In addition, these tests are expensive, invasive, and are certainly not easy to perform.

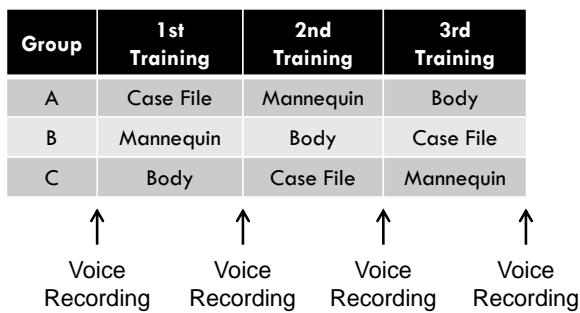
The authors have been pursuing research on technology that can estimate stress states based on one's voice [9]. Voice analysis has the advantages of being objective, non-invasive, and easy to perform.

Here we aimed to verify the efficacy of using voice in individuals in identification workshop to measure stress. We especially were interested in learning whether the use of mannequins for training helps reduce the stress associated with practice with actual dead bodies. We thus evaluated the participants' mental states based on their voices before and after training with dead bodies. We studied both participants who performed the actual-body practice after mannequin practice, and those who did not undergo mannequin training.

## 2. METHODS

### 2.1 Detail of Identification workshop

Members of this identification workshop practiced using actual corpses (below, "bodies"), mannequins, and case files. Participants were divided into three groups (A, B, and C) rotating through the different training paradigms to ensure that there was no simultaneous overlapping of training between the groups. Before and after each training type, the voices of participants were recorded in a room separate from the practice room. These recordings were then analyzed. Figure 1 shows a flow scheme for each group's practice types and voice recordings.



**Fig. 1** Flow scheme for training and voice recordings.

The participants ranged in age from 27 to 67 years. The study included 27 individuals (23 men and 4 women), as follows: police dentists (6 individuals), Dental Association members in charge of identification team (5), general dentists (8), university-affiliated dentists (8), other (1), and unknown (1) (it is noted that 2 participants were affiliated with two separate institutions). Group A included 10 participants, Group B included 7 participants, and Group C included 10 participants. The mean age of the participants was 46 years, with a standard deviation of 11.77.

### 2.2 Voice recordings

Voice recordings were performed in a small area blocked off by partitions to minimize the effects of noise. The participants were asked to read the same standard phrases before and after each training period. We used the 17 standard phrases shown in Table 1. The participants were asked to pause for 1 or 2 seconds before reading each phrase, and all phrases were read in order, from top to bottom.

Noise levels in the recording space were approximately 26 dB. The noise levels were measured using a high-function sound level meter, LA-3570 (Ono Sokki; Kanagawa, Japan).

The voices were recorded using a ME52W (Olympus; Tokyo, Japan) pin microphone attached to the chest approximately 10 cm from each participant's mouth. The recording device was a Portable Recorder R-26 (Roland; Shizuoka, Japan) and the recording format were 96 kHz and 24-bit.

### 2.3 Voice analysis

Voice analysis was performed using the Mind Monitoring System (MIMOSYS, PST Inc.) developed by the authors' research group. Recorded voices were analyzed after conversion to 11 kHz, 16-bit voice data.

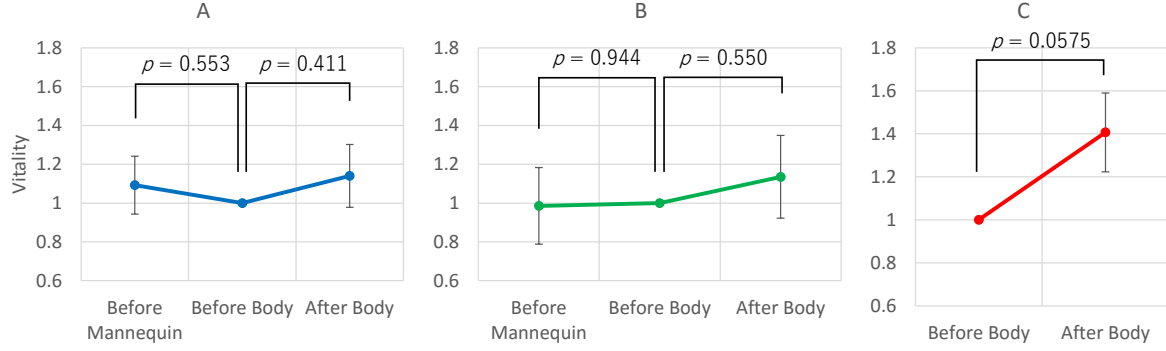
**Table 1** Standard phrases.

No.	Phrase
1	"i, ro, ha, ni, ho, he, to" [former Japanese equivalent of

	"a, b, c, d, e, f, g," and still (mostly) taught to children today]
2	It is a fine [clear] day today.
3	"with nothing better to do" [Donald Keene translation of the beginning line of "Essays in Idleness," a classical work from the 14 <sup>th</sup> century familiar to most educated Japanese individuals, especially this opening phrase.]
4	"I am a cat." [title of a novel by Soseki Natsume]
5	"Long, long ago, in a certain place . . ." [Japanese equivalent of "Once upon a time . . ."]
6	"a, i, u, e, o" [this phrase and those in nos. 7, 8, and 9 below are sequential sounds, equivalent in ways to the English alphabet, and just as familiar]
7	"ka, ki, ku, ke, ko"
8	"ra, ri, ru, re, ro"
9	"pa, pi, pu, pe, po"
10	"When I think of the path of life, I can't believe I've come this far." [Title of a popular song, then a movie, and then a television drama from the late 1970s and early 1980s.]
11	Galapagos Islands
12	I am tired and listless.
13	I'm feeling fine! [I'm in good spirits.]
14	I slept well last night.
15	I have a good appetite.
16	I'm easily irritated. ["I tend to get angry easily."]
17	I feel calm and peaceful.

The free software EcoDecoTool ver. 1.14 was used for the voice conversion.

MIMOSYS is based on vocal emotion recognition technology (ST: Sensibility Technology) [10]. Briefly, a mental state is quantified and output based on the voice. The emotions of the speaker are measure based on patterns of changes in fundamental frequencies within speech. Altered patterns of fundamental frequencies were analyzed, and the emotions included in the voice were quantified as levels of "Calmness," "Anger" "Joy," "Sorrow," and "Excitement." Using our



**Fig. 2** T-test significance probabilities ( $p$  values) corresponding to changes in the mean vitality of Groups A and B when comparing before mannequin training to after body training, as well as changes in the mean vitality of Group C from before body training to after body training.

technology, we quantified “vitality”, which is the mental state immediately after speech analyzed using ST. The “Mental Activity” was output as the quantification of the mid-term mental state. The values used were “1” or “0”, and higher values, were reflective of more favorable mental states. We evaluated vitality and the emotional components of different mental states before and after each training type.

The shortest unit in voice-emotion analysis is the “utterance,” which signifies a unit of continuous voice that is divided by breathing (intake or expulsion of breath). In actual practice, the beginning of an utterance is detected as the time when there is a change from silence (a non-sound state) to a vocalization state that continues for a certain length of time. The termination of that utterance is when there is transition from a vocalization state to a state of silence that continues for a certain length of time. Judgements of vocal utterance state or silence state are performed by setting threshold values for the amplitude of the time waveform of a vocalization. A minimum of seven utterances is required for voice analysis using MIMOSYS. Using the phrases shown in Table 1, a one-time recording of the set enables sufficient capture of more than seven utterances.

The following free software were used for statistical test: R ver. 3.3.2 and G\*Power ver. 3.1.9.2 [11].

### 3. RESULTS

#### 3.1 Vitality

Groups A and B performed mannequin training before body training, while Group C performed body training before mannequin training. Figure 2 shows changes in the mean vitality value from before mannequin training to after body training for Groups A and B, and from before body training to after body training for Group C. Note that vitality levels for each Group before body training have been standardized for comparison. Error bars show standard errors. T-tests were performed to determine whether there were significant changes in vitality before vs. after mannequin training and before vs. after body training for Groups A and B, and before vs. after body training

for Group C. Figure 2 also shows significance probabilities ( $p$ -value).

In the tests, the  $p$ -value was dependent on sample number and was not affected by actual sizes of differences. “Effect size” (ES) has been proposed as an index for the evaluation of differences. We have included ES in our evaluation. ES is an index that is not dependent on sample size. Cohen’s  $d$  [12] is a representative ES of the corresponding difference between two paired groups and is defined by the standardized quantity of the difference between the respective sample means of the two groups. That is,

$$d = \frac{|\mu_X - \mu_Y|}{\sqrt{\frac{\sigma_X^2 + \sigma_Y^2}{2}}} \quad (1)$$

where  $\mu_X$ ,  $\mu_Y$ ,  $\sigma_X$ , and  $\sigma_Y$  express respectively the mean values of groups X and Y, the standard deviations of groups X and Y. The following have been proposed [12] as criteria for ES sizes corresponding to differences between paired groups:

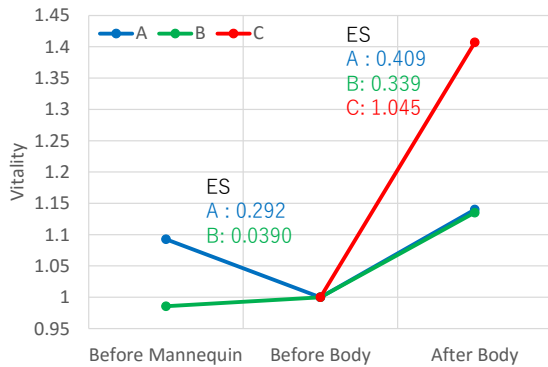
Small: 0.2, medium: 0.5, and large: 0.8 (2)

Figure 3 presents summary graphs for each group shown in Fig. 2. These graphs show ES values for changes in the mean vitality of Groups A and B before and after mannequin training, and before and after body training, and the ES value of the change in mean vitality of Group C before and after body training.

#### 3.2 Emotional component

Figure 4 shows changes in the means of emotion components before and after body training. Note that the emotional component values for each group before body training have been standardized for comparison. T-tests were performed to determine whether there were significant changes in the emotional components for each respective group before and after body training. Figure 4 also shows significance probabilities ( $p$ -values) for each of these comparisons. Figure 5 presents summary graphs for each emotional component in each group shown in Fig. 4. Figure 5 also shows the ES

values for changes in mean emotional components of each group before and after body training.



**Fig. 3** Effect size (ES) values of changes in mean vitality in Groups A and B before and after mannequin training, and before and after body training, and the ES value of the change in mean vitality of Group C before and after body training.

#### 4. DISCUSSION

In Groups A and B, no significant differences were found in mean vitality differences, neither before or after mannequin training, nor before or after body training. Inasmuch as the ES was also small, no actual differences were detected. We thus believe that there were no differences in vitality mean changes from before mannequin training to after body training in Groups A and B. Our results suggest that mannequin training improved tolerance to the stress of contacting a dead body.

Compared to Groups A and B, Group C displayed a major increase in mean vitality from before to after body training. Group C came into contact with a dead body before training with a mannequin. This was expected to lead to a decline in mean vitality after body training due to excessive stress. However, our results did not confirm our hypothesis. Nevertheless, a state of temporary excitement is said to exist immediately after exposure to intense stress [13]. Therefore, the increase in mean vitality after body training is thought to have been a manifestation of a mood upswing directly after exposure to intense stress. In Group C, we observed a tendency for a difference in mean vitality before vs. after training. Since the ES for this difference was an extremely high value, it is highly likely that there was an actual difference in mean vitality.

Based on the above findings, we believe that stress evaluation based on an individual's voice is useful, easy to perform, and can be performed in a limited amount of time during practice sessions.

In the present study, we were unable to obtain sufficient statistical significance. We believe that this is due to the low power of the test used. However, given the power of this test, it is probable that if a significant

difference were to in fact exist, this test would correctly detect that significance, as there is a tendency for decreased power when there are insufficient sample numbers [12]. We thus believe that the numbers of individuals assessed in this study were insufficient.

Below we will consider changes in the emotional components of Group C before and after body training. We observed a tendency for larger changes in Group C than in Groups A and B in components other than "Joy." While the change in the "Joy" component was larger for Group C than for Group A, the change for Group B in this component was larger than that for Group C. In Group C, the components "Anger," "Joy," and "Excitement" changed in the positive direction, while "Calmness" and "Sorrow" changed in the negative direction. We thus believe that Group C members were in a state of raised mood excitement after body training. Of the ES values corresponding to changes in mean emotional components in Group C, the ES of calmness was slightly lower than the medium effect from (2), that of the "Anger" component was extremely high, and those of the "Joy," "Sorrow," and "Excitement" components was larger than the medium effect from (2). These values thus had some differences. These tests also had low power, which is thought to be the reason for our inability to detect significant differences.

Changes in the means of the emotional components in Group B before and after body training showed similar tendencies to those in Group C. However, since the ES values were small for components other than "Joy," no actual differences are thought to have existed. While the ES of changes in the "Joy" component was higher than the medium effect from (2), the standard error was larger for Group B than for Group C. Thus, despite the change in the medium ES value in Group B, the reliability of this change in the "Joy" component was less than that for Group C. In fact, the ES of changes in the "Joy" component for Group B was smaller than that for Group C.

#### 5. CONCLUSION

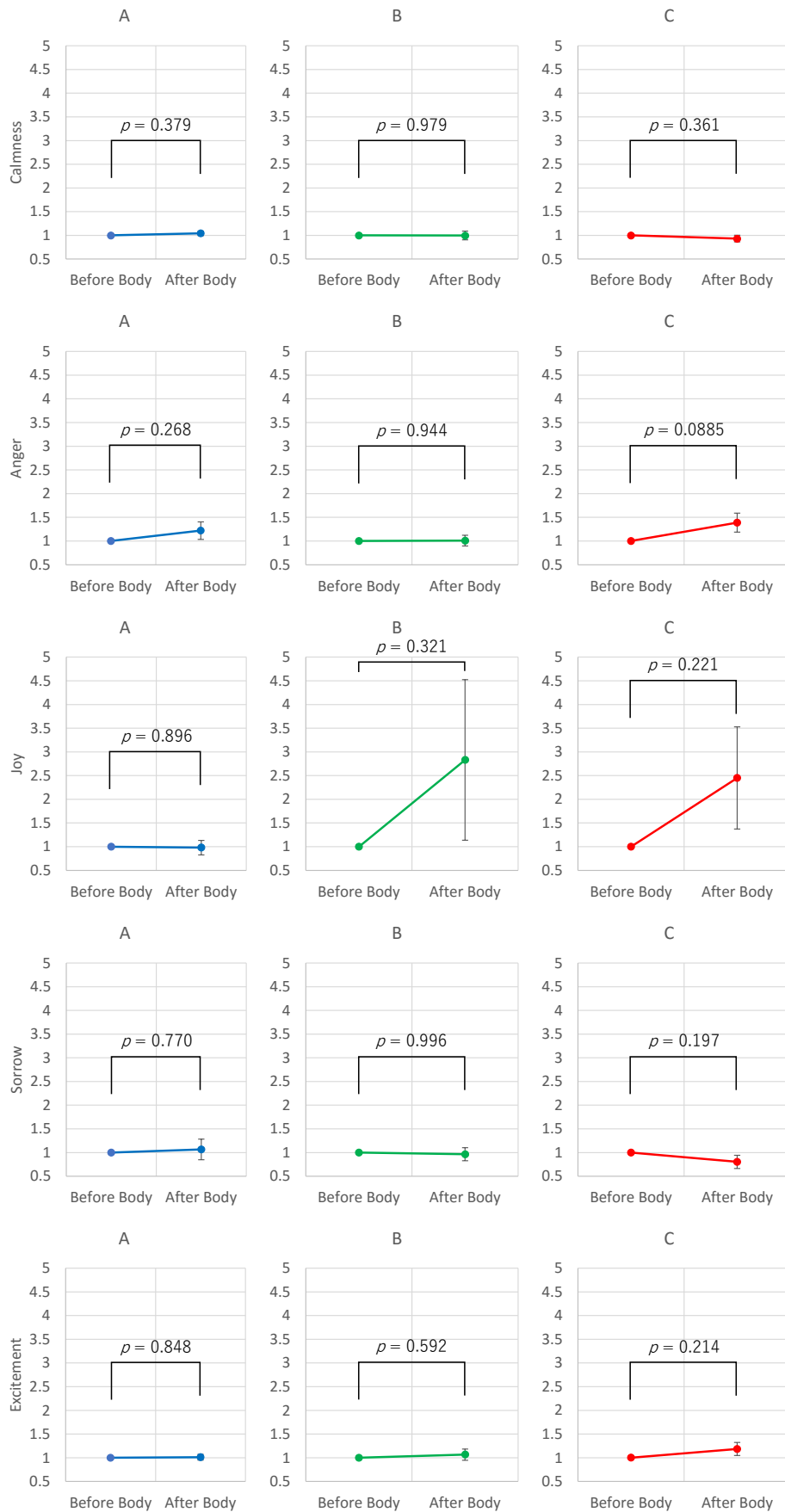
To ascertain the efficacy of stress measurements using voice analysis, this study used voice analysis to perform stress evaluations of dentists and other individuals in identification workshop.

Our results suggest that the use of practice mannequins may have improved resistance to the stress following interaction with the dead bodies. We were thus able to confirm the efficacy of stress evaluations using voices of individuals. We also believe that this technology can be used at actual disaster-response sites.

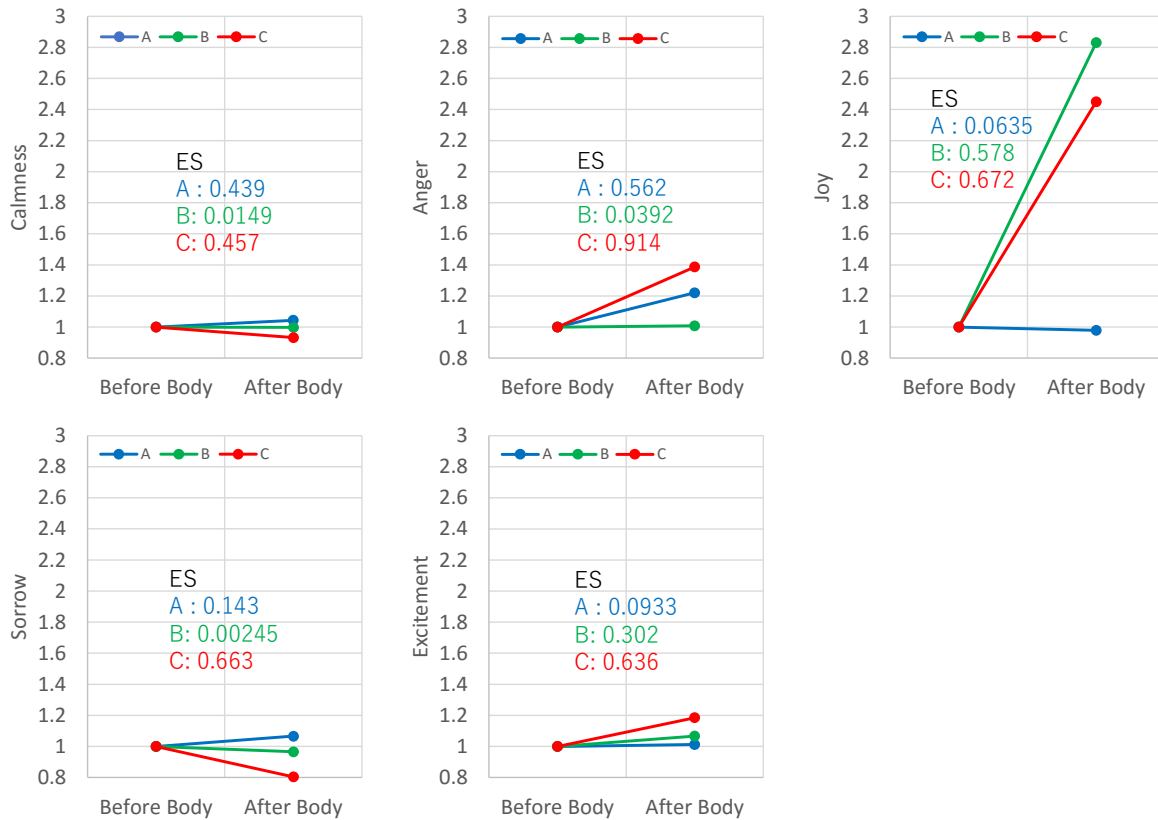
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**Fig. 4** Changes in the means of emotion components for each group before and after body training, and t-test significance probabilities (p values) corresponding to these changes.



**Fig. 5** Changes in the means of emotion components for each group before and after body training, and effect sizes (ES) corresponding to these changes.

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# MULTIDISCIPLINARY APPROACH TO STRATEGIES AND ORGANISATION: A CASE STUDY IN MARINE TOURISM

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**Abstract:** *This paper presents the results of the research on the topic concerning the synergy of multidisciplinary strategic and situational approach to organization in Ada Bojana Sports Centre at the Adriatic Sea, with the aim of achieving organizational improvements in this concrete case. A theoretical base is given and afterwards also the results of practically applied Osterwalder and Pigneur organization model. Business Model Canvas methodology is applied, and SWOT analysis is performed. Structural and situational approaches close to each other were analyzed, based on the real organization model of the sports recreational educational ecological tourism centre in Montenegro, which was seen as a business system, whose strategy and organization are based on multidisciplinary approach. A survey was conducted among tourists, confirming that the chosen business development strategy of multidisciplinary approach is attractive and it was concluded that, consequently, the number of tourists is increasing. Multidisciplinary approach within development strategy of this tourist centre opens new organizational improvements, especially in the domain of optimal employee engagement dynamics and thoughtfully designated time for tourists, regardless of meteorological stochastic conditions. E multidisciplinary offer presents additional opportunities for increasing profitability and better positioning in the “Red Ocean” of a competitive market. Further research can be directed towards strengthening multidisciplinary approach, cluster formation and eventual mapping of multidisciplinary approach from marine to mountain tourism.*

**Key words:** *multidisciplinary approach, strategy, organization, case study, tourism.*

## 1. INTRODUCTION

Classic theories of Shavritz et al. (2015), within context of a series of new interdisciplinary insights, Săvoiu (2014), are today complementing and changing in the direction of multidisciplinary approach to strategy and organization. Hence, for the purpose of research in this paper, a tourist sport centre organization – water sports schools Dragonproject CO – was chosen, which is holistically researched as a business system, firstly at present state, and afterwards organizational improvements are sought through multidisciplinary approach.

The goal of each business system is to find an inherently optimal organization form in order to function successfully within the defined business nomenclature, regardless of whether their product represents goods or services in a competitive market, as is the case with Dragonproject CO.

Dragonproject CO believes that success can be achieved by multidisciplinary approach to strategy and business system organization. The main goal of this paper is to explore the

current organization of Dragonproject CO business system through various theoretical settings and methods, and to determine whether, and how to define possible improvements through the multidisciplinary approach.

One of the goals of this paper is to combine, in this case, two adequate approaches to business systems organization: strategic, Heath & Palenchar (2008), and situational, Pan & Tan (2011), to design and analyze empirically their synergy on the concrete example of Ada Bojana Tourist Sports Centre, through thematic definitions and settings. The idea of imperative correlation dependence and mutual complementarities of strategic and situational approach to this case study was subject to critical analysis through theory and empirical structural examples, Morgan et al. (2006).

The aim is to research 9 key elements of a business model, similar to Osterwalder and Pigneur model, according to the literature Osterwalder et al. (2014), developing the Business Model Canvas methodology, researching possibilities of achieving more success in strategic organization by SWOT analysis, as well as checking chosen multidisciplinary approach by survey among tourists with the goal of exiting the “Red Ocean”, thus maintaining specific, special identity in a spirit of sustainability.

The research carried out in this paper is presented in four chapters. The introduction presents basic points, subject and purpose of this research, as well as literature review within this domain. The multidisciplinary nomenclature of Dragonproject CO business and current problematic competitive situation on the market, for which the solution being investigated is defined. The second chapter describes applied research methods. The third chapter describes the synergy results of the multidisciplinary strategic and situational approach to Dragonproject CO business system organization, analogy with Osterwalder and Pigneur organization model, Business Model Canvas methodology, SWOT analysis and indicative results of conducted survey – a questionnaire for tourists confirming the analyzed, chosen multidisciplinary approach to strategy and organization as a solution of escape from the “Red Ocean”. The fourth chapter provides concluding observations and recommendations for further research.

### 1.1. Multidisciplinary nomenclature of jobs in Dragonproject CO

For the subject of research carried out in this paper, the business system of kite surf and windsurf tourist centre was selected, whose multidisciplinary nomenclature of activities includes: rental of sports equipment, tourists, youth and adults trainings in extreme, exclusive water sports, creative psychological workshops, seminars from human resources management, production of environmentally pure renewable

electricity. Activities include organization of accommodation, healthy food and cultural entertainment, as well as education and promotion in the field of environmental protection, and in the function of sustainable profitability – Porter (2011).

Dragonproject CO at Ada Bojana has existed since 1993. It is a tourist centre, school and club of extreme water sports that operates under the conditions of a free market, therefore it is considered in the following text from the perspective of organizational models, and in the function of business success and sustainable profitability.

In the previous season, a mini-solar-powerplant was installed on the roof of a house on pillars over water, which supplied the camp with green energy produced from 2 m<sup>2</sup> photovoltaic solar panels, making this environmentally friendly sports and a recreational educational tourist centre unique in the region of Otrant Gate and worldwide, Stevović (2016a).

This ecological sports and recreational educational camp is organized on two micro locations. One location is at the nudist island itself, and the other location is at the 14 km long Grand Beach in Ulcinj, 1km away from the mouth of the river Bojana into the Adriatic Sea. Both locations are in the zone of Otrant Gate, with strong winds and the largest annual amount of sunny days on the Adriatic coast, which represent basic natural resources of this tourist centre.

In stochastic hydro meteorological conditions and with high levels of entropy and risk, it must be noted that the organization of this business system is bordering on chaos management – Gharajedaghi (2011).

Most organizational activities take place in rough natural conditions: sandy beach, sea, sun, wind, waves. The Tourist Centre represents an isolated unit and provides a unique experience for tourists and athletes through various multidisciplinary cultural, educational, entertainment and sports programs and various kinds of water sports, for which the state-of-the-art equipment is adapted to beginners and competitors.

Each year, at the beginning of a tourist business season, investment is made in ever so modern boards, sails and kites. Every most modern devices that appear during the current year on windsurf, kite and various sailing equipment market worldwide is procured and made available to students and/or athletes who come solely to rent equipment.

The tourist centre provides a set of characteristic services: accommodation in wooden houses – set on pillars over water surface, camping and beach life, water sports (kite surf, windsurf, wakeboard, sailing and catamaran). At the same time competitions and special multidisciplinary programs for children and adults are held, with the aim of popularizing sports, education and healthy living in accordance with nature and preservation of environment itself, and in the context of sustainability.

## 1.2. Market competition and goals

Dragonproject CO was founded in 1993 in Ada Bojana, a sandy island at the mouth of the River Bojana into the Adriatic Sea, near the border between Montenegro and Albania. At that time, it was the only tourist sports centre and school on the Adriatic coast, and it worked in the conditions of the “Blue Ocean” – there was no competition. Today, serious international competition has arisen and is increasing every

day. The microclimate of Otrant Gate and a large number of sunny days during the year provide unique conditions for development of water sports, making this site extremely attractive, so that along the Grand Beach new tourist centres are established continuously, with owners from different countries worldwide.

Each of these tourist centers, as a business system, could be associated with others in the so-called „Business Groups” by Granovetter (2010). Although they are competitive, a great number of different organizational modes for each business system is achievable, with the goal of independent business, and again in the function of business success, Jasko (21017).

However, competitive relationship is retained and consequently influences the fluctuation of employees from one tourist centre to another, as well as the cost of work, regardless of the business system organization modality, Meade (2013).

Tourist companies from Russia, Germany, Poland, Slovenia and many other countries, establish windsurf centres, but in addition to their surf schools, they are more oriented to management of cafes, discotheques and optional organization of various entertainment contents on the beach, in the name of higher profits, regardless to environment, common sense and sustainability. Dragonproject CO keeps focus on multidisciplinary approach, sports, education, essential advancement, healthy life and nature conservation. This school is looking for a purpose above profitability – sustainable profitability.

The question is how to maintain a prestigious business position and not to lose own, identifiable identity, as authors Hatch & Cunliffe (2012, 211) wrote about this in their book.

As the tourist sport centre as a company neither adapts to the trends and mass taste of today’s young tourists, nor does it accept development in the direction of becoming a disco on the beach, this has significantly affected the decline in profitability in the past two years.

There was a problem and dilemma whether Dragonproject CO, as a tourist centre can survive as a surf school, with its own, distinctive identity. What are the strategic organizational moves that must be changed, retained and undertaken in order to keep this sports centre within defined work criteria and system of values, and to achieve satisfactory profit, bearing in mind that due to expensive quality equipment and safety at work, big financial resources are needed?

Therefore, the goal of the company is to ensure profitability, but retaining authenticity in terms of multidisciplinary approach, focusing on sports, knowledge, upbringing, nature and development only as long as it is sustainable.

## 1.3. A multidisciplinary approach to strategy and organization

A multidisciplinary approach to strategy and organization of Dragonproject CO involves the engagement of a multidisciplinary team of professionals, aiming at synergy of various disciplines, Čudanov (2013). This multidisciplinary concept encompasses several disciplines, and the most frequently and clearly stated are the following:

- organization of education
- ecology – environmental protection through workshops, seminars, lectures and practice on example model of mini

solar power plant for production of renewable pure green energy

- organizing sports activities
- organizing cultural entertainment program

### 1.3.1. Education

Educational programs are organized in the domain of local area geography, analogous to positive practice worldwide (the best practice), similar to international research projects in Himalayan mountain ranges, India and Pakistan, Bishop (2009). Compulsory educational programs also take place in the domain of health care, which includes a spectrum of first aid methods and various forms of treatment, from traditional to most modern procedures, which are applied in the 21st century, as described in Lavin et al. (2001).

The strategic goal of Dragonproject Tourist Centre is to prepare clients for solving problems in an increasingly international and multidisciplinary world, after being present at offered programs and workshops. As John Kennedy emphasized, “Change is the law of life. Those who look only to the past or present will surely miss the future” Savoii (2012).

Dragonproject CO performs a serious selection of employees before beginning of each season, primarily using social networks, Čudanov & Kirchner (2016). Multidisciplinary prepared and highly educated employees at Dragonproject CO lead clients through a model of adaptation to natural, very variable physical conditions. Innovative educational processes are created from games, as in the literature Parlić et al. (2014), to serious survival training in rough conditions. The goal is to successfully prepare clients for life in today’s fast-changing world.

### 1.3.2. Ecology

Aiming at sustained profitability and as a multidisciplinary approach, Dragonproject CO has incorporated into business strategy that the environmental quality criterion is always satisfied, Shao et al. (2011).

Ecology is a domain, which today is unjustifiably neglected. One of the strategic goals of Dragonproject CO is to raise awareness of the importance of using renewable energy sources (RES) compared to non-renewable energy sources. Non-renewable energy sources, beside the fact that their reserves are estimated for a maximum of 150 years, generate high environmental pollution in production of electricity and cause global warming, Evans et al. (2009).

This strategic goal was realized by installing a mini-solar-powerplant on the roof of a house built on pillars over water, Stevović (2016a). Clients are enabled to witness directly in practice the application of innovative solutions and positive environmental effects of renewable solar energy production on the example model 1: 1, Stevović (2016b).

In addition to this, strategic objectives include lectures of experts in this domain, in a spontaneous atmosphere on the seashore, where the word moves to deed and live is based on OIE, wind and sun.

### 1.3.3. Sports

The main development strategy of Dragonproject CO relies on sports activities. Although they comprise more disciplines, they all rely on the OIE, and only wind is used to run it. An exception is made by fast boats engaged in emergency situations to rescue trainees, if the wind takes them to the open sea and they cannot return.

All sports disciplines belong to elite sports and the knowledge of these skills separates clients from others and makes them psychologically self-confident, Fletcher & Wagstaff (2009).

Dragonproject CO has a strategy to carry out all activities, although highly serious, sometimes dangerous, through discipline, modern game concept, relying on creativity of employees, Parlić et al. (2014).

### 1.3.4. Culture and entertainment

Dragonproject CO’s strategic goal is to separate itself from the “discotheque on the beach” competing model. Lectures, psychological workshops and playrooms are organized with the aim of teaching communication, behavioural and speech culture, in an attempt to redefine entertainment in fine events with inspirational, sophisticated, multidisciplinary conversations in the domain of culture, history, philosophy – Baldwin et al. (2006).

In this tourist centre, besides limitless sports, fun is limited to listening to selected music, given how many types of music can affect mood and thinking – Barthet et al. (2012).

## 2. RESEARCH METHODOLOGY

Research on multidisciplinary approach of organizing the business system of this tourist sports centre was done using several methods of Savoii (2014). The methodological holistic approach, Sarkar (2007), includes methods of induction and deduction, analysis and synthesis, as well as an analogy between, in literature well known, theoretical models and approach to business systems organization, with concrete example of Dragonproject CO. The case study method has also been applied.

The method of deduction, as shown in literature Hintikka & Remes (2012), has started from the general theoretical case of the business system organizing to the concrete case of Dragonproject CO organization. Certain conclusions were drawn from individual examples, and in particular through analyses of the case study of the sports tourist centre in Ada Bojana and by the induction method – Bas et al. (2007).

As according to Cassell & Symon (2004), Porter’s generic strategy is theoretically broken down into strategic patterns: cost leadership, differentiation, focused cost leadership and focused differentiation, the same is done as a case study for Dragonproject CO by analogy method. Also, through the method of analogy with theoretical approach by Henri Minberg, Janičijević (2012), the business success and performance of Dragonproject CO are broken down into appropriate hypotheses in practice on a concrete example.

The SWOT analysis method was used to understand and make decisions in various situations in work and organization of the Dragonproject business system.

The Business Model Canvas methodology was also used during research of the Dragonproject CO business model.

The results of the survey were complemented by the survey method, Garcia et al. (2008). Experimental research was conducted in July 2017 at the Ada Bojana Tourist Centre on a representative sample of 74 respondents. A survey questionnaire was used as a research instrument. Answers to the questionnaires were processed using statistical methods, Hanushek & Jackson (2013), and the data collected were processed using Microsoft Excel and SPSS for Windows 13.0 software packages.

Therefore, the respondents were actually tourists – guests at Ada Bojana Tourist Centre, in the cut-off time on July 6th 2017. The questionnaire is given in Appendix A.

A literature review method was also applied. The searched journals include all the aspects of multidisciplinary approaches to strategy and organization, since searched justification of definition to multidisciplinary activities is explored as a solution to a compromise between the goal of retaining one's own identity and ensuring survival in a competitive market.

### 3. RESULTS AND DISCUSSION

The concept of solving organizational problems in order to improve organization and profitability, resolved by a multidisciplinary approach, is reflected in several contemporary organizational theories, some of which are intertwined and supplemented, as for example strategic and situational approach, Jasko et al (2013a). This concept is highly characteristic of the chosen example of Dragonproject CO, due to the specificity of the multidisciplinary activities and business conditions. The synergy of multidisciplinary strategic and situational approach gives the best results in the analysis of a business system organization.

#### 3.1. Strategic approach

As Michael Porter has said a long time ago, not all organizations have equal opportunities for sustainable profitability. Dragonproject CO has great predispositions to realize sustainable profitability, because it has based its development strategy and its offer on a multidisciplinary approach. In addition, by targeting activities in the field of sports, culture, education, economics and environmental protection, Dragonproject CO practically realizes the paradigm of sustainable development. Additional environmental concerns have been incorporated by investing in construction of a mini-solar-powerplant as a renewable source of clean green energy and as one of its strategic goals,.

According to the theory of Porter's generic strategies, there are following strategic templates: cost leadership, differentiation, focusing on cost leadership and focused differentiation. Dragonproject CO, as an organization with defined specific business objectives and multidisciplinary business nomenclature, applies the strategy of focused differentiation.

Dragonproject CO has a strategy to distinguish itself in this segment by the diversity of its multidisciplinary offer compared to the competitors, and not by low prices. Therefore, Dragonproject CO is not focused on the low prices of its services. Aware of quality, variety and specificity of its offer, Dragonproject CO even keeps high prices in relation to

competitive domestic and foreign tourist centres. Dragonproject CO tries, and is really different and unique in terms of variety, quality and specificity of its offer.

The problem arises when consumers do not recognize, and do not tend to the goal set by this company – sustainable profitability. This problem is solved by the fact that tourists decide for centres in accordance with their preferences and convictions.

Dragonproject CO's business analysis shows that the sports tourism centre as a company has been operating in the "Blue Ocean" environment for 20 years, as competitor sports centres began to appear only in the 21st century. Until then, Dragonproject CO was the first and unique surf school on the coast of the Adriatic Sea.

Today, the environment is a "Red Ocean", because only on Grand Beach in a range of 12 km there are more than 10 international sports centres with relatively similar offer. Serious research is needed on various business enhancement strategies for Dragonproject CO to survive and be profitable, and Dragonproject CO is looking for them in the field of multidisciplinary approach.

#### 3.2. Situational approach

The organizational model of Dragonproject CO definitely needs to be adapted and the situational approach is implemented in the concept of solving organizational problems, depending on the situation dynamics in the field. The situation theory of business systems organization, which relies on the view that each organization has a unique structure and dynamics, is quite appropriate in this case. Today it has been proven in theory – Jasko et al (2013b), and in practice it has been confirmed that there is no unique approach to all problems in an organization, as organizations are different, as well as their activities and environment.

Dragonproject CO is distinctly different from other companies and it is very difficult to perform formalization. It is definitely specific to its multidisciplinary activities, different professional employee profiles, location and organizational structure, which covers several areas of operation, Ćirković (2016). Specific characteristics of Dragonproject CO business are conditioned by a number of different parameters, starting from the spectrum of different age and gender structure of employees, tourists, through different levels of knowledge and skills of participants, to different weather conditions, as stochastic size, which is also a security imperative – the company works safely in terms of safety of tourists and equipment.

Dragonproject CO operates under the conditions of a high entropy factor, related to the number of tourists and necessary level of equipment engagement and the company operates also within meteorological stochastic changes that take place at a time level, which really requires a specific organizational structure, capable of dynamically adjusting to newly emerging situations.

Dragonproject CO, in conditions when there is no wind, which is the basic precondition for carrying out main declared activities, offers tourists a bunch of other multidisciplinary activities, in the domain of education, culture, entertainment, ecology.

According to Henri Mintzberg, Janićević (2012), analogous to the theoretical model, in order to achieve business success

and high performance for Dragonproject CO, it is necessary first to analyze and then proceed from following assumptions: configuration hypothesis, congruence hypothesis, and extended configuration hypothesis.

The congruence hypothesis applied to Dragonproject CO business system represents the degree of interconnectedness of all parameters and the all multidisciplinary activities that are highly coordinated in time and space by Dragonproject CO, as well as from the engagement of multidisciplinary team of professionals.

The specificity of Dragonproject CO business does not allow it to function only according to the principles of conceived, projected organization. Stochastic hydrological changes and general meteorological conditions often require Dragonproject's parameters to be subordinated to the situation factors. For example, changes, i.e. large increase in wind speed and intensity sometimes requires suspension of certain activities on the open sea and the imperative of designing other activities on the beach, adapted to new weather conditions. Finding solutions in newly created situations is sought in a multidisciplinary offer, by which Dragonproject CO adjusts to the situation.

The congruence hypothesis is realized in Dragonproject CO with high probability, because due to frequent changes in hydrological conditions, which are the starting point for certain activities, the parameters of the Dragonproject CO organization is very often adapted to newly emerging situations. This is in fact the principle of functioning of prepared multidisciplinary team of employees.

The extended configuration hypothesis on the concrete example of Dragonproject CO is realized with a high probability of occurrence, because the environment, in which Dragonproject CO functions, generates a high degree of uncertainty. It is not certain when, with which intensity and direction the wind blows, which trainees can be engaged in activities, which are optimal sizes of rental kites, and then it is not certain how long hydro-meteorological conditions will last from the beginning of the day, i.e. zero level. Sometimes it is necessary to engage quick boats for returning trainees from the open sea. Dragonproject CO responds to environmental uncertainties by adjusting its parameters, so assumptions of configuration and congruence are fulfilled at the same time.

The uncertainty is explained correlated with daily changes. There is also uncertainty over duration of the season, in terms of the number of tourists and general economic conditions in a wider environment, which can affect the prices of food, fuel and other material costs.

### 3.3. Analogy with Osterwalder and Pigneur organization model

In order to better understand the environment in which Dragonproject CO is located and to define how to proactively/reactively adapt the company, with the aim of designing a more competitive business model on the market and higher profitability, 9 key elements were analyzed. In analogy to the theory developed by Osterwalder and Pigneur, Osterwalder et al. (2014), these elements emerged from 4 business segments (users, offer, infrastructure and financial sustainability) and are further analyzed for specific case study:

**Consumer Segments** – Dragonproject CO has dominantly directed its creation of values into foreign tourist groups and

young athletes and/or those who want training in specific adrenaline sports. Target groups are also tourist organizations from abroad and within the country, to which this sports attraction is offered as a motive for visiting or additional activities.

**Value proposition** – Dragonproject CO provides services to tourists and generates revenues from training and equipment rental, as well as from direct sale of state-of-the-art equipment, which appeared on the market as an innovation during that year, which represents value and rarity in the tourist offer of this type. At the same time, certain revenues come from accommodation and sale of food and beverages. Innovative value in Dragonproject CO represents ecologically pure, green solar energy produced in a mini solar power plant, which carries the attributes of better quality accommodation and general residence, in a zone where the noisy work of diesel engines is not heard. A novelty that contributes to the creation of consumer values is also a spectrum of cultural education, entertainment programs and multidisciplinary contents.

**Distribution channels** – Distribution channels of Dragonproject CO are created on the Internet (the company has its own site and Face book), through agencies, personal and group information transmission on the quality and specificity of multidisciplinary offerings, directly and indirectly through channels of partner companies. On micro plan and daily level of organization, a distribution channel is also representing a vehicle fleet for supply of food and beverages, as well as for transportation of tourists on arrival and departure.

**Customer relations** – Dragonproject CO has a very characteristic, maximally personalized access to service users, which, in addition to targeted strategy, stems from the necessity of 24 hour coexistence in extremely difficult meteorological conditions. Dragonproject CO acquires, retains and extends the sale of its services, based on recommendations, through various tourist and sports communities, and modern possibilities of information communication technologies and other forms of communication and advertising:

1. *Awareness* of quality and special features of Dragonproject CO services is raised through an official, website, social internet networks, blogs and direct information transfer, as well as advertising through travel agencies.
2. *Evaluation* and credibility of offered service value is done through direct and personal contacts, social internet networks and by written reviews.
3. *Purchase* of equipment and all offers of Dragonproject CO are made over the internet during the year and during the high season (June-September) via internet and directly in the Tourist Centre.
4. *Delivery* of offered values of Dragonproject CO business system is carried out during the year alternatively or in combination with car, bus, train and/or ship, depending on the consumer location. During the year, out-of-season equipment is usually offered for sale. These are the working modes as the equipment is too large to be delivered by plane, unless otherwise required by the consumer. In high season, delivery takes place in the same way and directly in the Tourist Centre, where besides equipment for sale, a whole range of other multidisciplinary activities and services are offered.
5. *Post-sales* support to consumers is ensured through possibility of providing additional courses and education,

as well as the possibility of complaints on purchased product.

**Revenue flows** – The most common revenue flows of Dragonproject CO are generated as cash, during high season, in direct contact with the consumer at the Tourist Centre. The list of prices is fixed, but there are also negotiations about lowering the prices, in the scope function of required services and yield management, i.e. depending on how successful the business year is and whether there is an overload of engaged personnel. Revenue flows are also realized through sale of property (equipment and parts of proprietary right over the Tourist Centre) and compensation for use of accommodation, food and beverage services. Revenues are realized through subscription, which most often works through business relations with tourist agencies from abroad. Certain income flows are also realized through renting equipment and organizing courses for obtaining international instructors licenses. Everything takes place under auspices and with approval of the International Kite Organization (IKO).

**Key resources** – Human resources are key resources in Dragonproject CO. First of all, it refers to a valuable multidisciplinary team of professionals in the domains of sports, culture, entertainment, environmental protection and various forms of education. Key resources are also financial resources necessary for starting the season and for procurement of equipment. Physical resources are in two different locations. These are two unique spaces, convenient for carrying out the main activity – courses in windsurf and kite. One is on a 100 m wide and 500 m long sandy beach, without any obstacles that could make it difficult to lift and lower the parachutes and sails. In addition, sand is an incomparably more convenient ground compared to the locations of other tourist centres worldwide, where there is a danger of tourists and equipment being damaged on sharp rocks or stones. The other exclusive location is at the mouth of the River Bojana into the Adriatic Sea, where a 1 km wide and 2 km long lake is formed, which represents ideal conditions for beginners, as there are no waves. Physical resources include houses on pillars over the water for accommodation of tourists, restaurant capacities and equipment hangars.

**Key activities** – Most important activities are from the spectrum of multidisciplinary approach: selling and renting of equipment, maintaining various courses in the domain of extreme water sports, solving problems arising from accidental situations regarding damage or loss of equipment on too heavy wind, and psychological workshops and playrooms when there is no wind and when activities are based on the shore. There are also educational courses and cultural and entertainment events.

**Key Partnerships** – Dragonproject CO key partnerships are with foreign and domestic tourist agencies, which bring tourists and represent distribution partners, and expand their value proposition, Jasko et al. (2017). Partnerships are also being implemented with competitive tourist centres in the area of providing emergency equipment and fast rescue boats in accidents, with the aim of reducing costs. Namely, there is a legal obligation to have fast boats for rescuing tourists in accidents on the open sea. Risky situations may also emerge through the proximity of the Albanian border, so in cases of strong winds and dropping of sails or parachutes, tourists can easily find themselves in another country. Two tourist centres,

although in a competitive relationship, are united in such cases and use a common quick speed boat.

In addition, Dragonproject CO has established partners, which make up the supplier's network at an annual level (sports and supporting equipment, material for building of houses on pillars over the water) and at a daily level (food, water, energy).

**Cost structure** – Fixed costs are annual beach lease and fixed taxes. It is specific that employee's wages also fall into variable costs, as the number of employee's changes during the season, adjusted to the number of tourists and hydro-meteorological conditions. Changing hydro meteorological conditions directly affect the duration of high season and consequently change the level of the multidisciplinary and professional team engagement and the costs for their work. Similarly, the costs of purchasing goods and new equipment are also changing. Variable costs are also fuel costs for a diesel engine and food and beverages supply vehicles, as well as food and beverages for tourists and employees. So, all costs are variable at a daily, weekly, monthly and annual level, except for fixed annual beach lease and taxes.

Dragonproject CO acts primarily proactively, but also reactively considering the high degree of entropy and stochastic. There is a great diversification of tourists; it is not known exactly what the age, educational and gender structure of coming groups will be, in order to optimally adapt procurement of equipment. Meteorological operation conditions are also unknown and variable, even at a one hour level, which requires a high degree of organizational flexibility.

### 3.4. The Business Model Canvas for Dragonproject CO

Within the multidisciplinary approach, Business Model Canvas (BMC) is also applied on Dragonproject CO with the goal of describing, designing, challenging, and pivoting the business model. It works in conjunction with the Canvas Value Proposition and other strategic management and execution tools and processes – Joyce & Paquin (2016).

The BMC model is detailed elaborated for Dragonproject CO and shown in Table 1, next page.

### 3.5. SWOT Analysis

Use of the SWOT analysis method is required in respond to the question how to maintain specificity identity, essential approach to education in sport, life and preserved environment, and again to have a sufficient number of clients in order to enable the school as a company to survive and have profit. In the past 2 years advantages, disadvantages, chances and hazards for the Dragonproject CO business system are analyzed within the framework of conducted research, in order to solve the problem with the number of clients.

**Advantages:**

- The offer of Dragonproject CO is positioned in a rich spectrum of multidisciplinary activities, ranging from extreme sports courses for adults and children, through psychological workshops and various educational actions, to human resource management seminars and construction of a solar power plant.
- Clients have the option of choosing. It is being operated at 2 locations (on the island of Ada Bojana and Grand



Beach), which allows the courses to be held on exciting sea waves and on a calm flat water surface at the mouth of the River Bojana into the Adriatic Sea, which is very important and improves safety and quality of the working process – learning.

- In Dragonproject CO main activities take place on the world-famous medicinal sand of Ulcinj, which provides comfort and security for clients, which only few tourist centres in the world have as a resource.
- Dragonproject CO is the first school of its kind in this region and has a respectable and recognizable name, many tourists have built a relationship of trust and continue to visit Dragonproject CO, where they are feeling good and have no need to change the location.
- Dragonproject CO employs instructors with international IKO licenses (International Kite Organization).
- 95% of Dragonproject CO equipment has been purchased in the current year, only 5% of equipment is sailing boards between 1 and 5 years old. These are wide boards that are kept because they are suitable for beginners.
- Dragonproject CO is recognized in the region with its multidisciplinary approach and focus on sports, education, healthy living and preservation of nature and the place itself just as it is.
- Dragonproject CO possesses specific multidisciplinary programs and equipment for children.
- The Dragonproject CO location is characterized by peaceful and quiet, unspoiled nature.

#### Disadvantages:

- The problem of synchronizing organization, management and control of work and equipment on two locations requires a great number of engaged instructors, which increases the costs of doing business.
- The access road from the Adriatic Highway to Dragonproject CO on the beach is an uneven, earthy road, which is dusty when it is sunny, and dangerously slippery and with zones of stained water when it rains.
- Dragonproject CO operates under conditions of isolation in relation to the electric power system and there is no water supply. Hence the irregularities in electricity supply, since sources of this isolated power supply system away from electricity grid are: limited solar power plant capacity (200 W) and a diesel generator. Water is also a problem solved by the construction of a local well, whose work is again conditioned by inclusion of a diesel engine, which implies the lack of continuity.
- In order to cover a wide spectrum of multidisciplinary activities, the café/restaurant is positioned in the last place, so that the nutrition problem for employees and tourists is recognized, who are forced to go to other centres for better and more diverse nutrition.

#### Chances:

- Retaining accomplished and strengthening multidisciplinary approach.
- Cooperation with even bigger and better-known foreign tourist agencies on the market.
- Cooperation with various sports clubs (various clubs can come for preparations, which currently exists as a practice, but underdeveloped). So far, the Youth Karate Club and table tennis player veterans came for preparations.

- Broader education of young people (about water sports, independence, healthy psychophysical life, life in nature, importance of preserved quality environment and culture).
- Development of a serious surf centre with globally recognized methodological multidisciplinary approach to organization and leading training programs for all levels of knowledge and all age of clients.
- Better and more adequate work schedule with clients of different knowledge levels, in comparison to other tourist centres, since Dragonproject CO is the only centre that operates at 2 locations (one on quiet upland water at the river mouth for beginners and the other on open sea and waves for advanced competitors)
- Dragonproject CO possesses a unique ecological camp with an experimentally installed mini solar power plant and possibility of installing a permanent mini solar power plant and supplying the camp with electricity from renewable sources of clean, green energy.
- Considering the site scope, with involvement of a large number of licensed instructors and other support staff, cooperation capacities (current the daily turnover is about 80 tourists) can, and should be doubled.

#### Hazards:

- An increasing number of competitive schools that follow habits and tastes of the majority of youth, eager for easy spending, a bit of light sport and showing off in beautiful beach bars, indoors and outdoors.
- The isolated location of the Tourist Centre can sometimes cause distribution or procurement problems, or inability to reach hospital in emergency situations more often than in other tourist centres, bearing in mind that the main program of extreme sports is on water.
- No connection to transmission line and isolation in relation to electricity system poses a risk of possible failure of freezers, fridges and inadequate stored food.
- The Tourist Centre is located on the beach and is not connected to the water supply network of the nearest city of Ulcinj. The absence and irregularity of water supply from the local well, in addition to reduced comfort, is at the same time a serious danger to the health of tourists and employees.
- Poor marking and bad advertisement on the main road have caused in several occasions that tourists who went to Dragonproject CO go astray on the road and drive to another tourist centre, which disturbs programmed capacities and reduces planned profitability.

Table 1. The Business Model Canvas for Dragonproject CO

<p>8.Key Partners:</p> <ul style="list-style-type: none"> <li>➤ Foreign tourist agencies</li> <li>➤ Tourist agencies from the country</li> <li>➤ Strategic partners from “Red ocean pool” (Russian, German and Slovenian companies)</li> </ul>	<p>7.Key Activities</p> <ul style="list-style-type: none"> <li>➤ Different sport courses</li> <li>➤ Selling of the equipment</li> <li>➤ Renting of the equipment</li> <li>➤ Tourists accommodation</li> <li>➤ Different educational courses</li> <li>➤ Different cultural events</li> <li>➤ Fun events</li> <li>➤ Cooking</li> <li>➤ Barmen activities</li> <li>➤ Energy production</li> <li>➤ Water supply</li> </ul>	<p>2.Value Propositions:</p> <ul style="list-style-type: none"> <li>➤ The equipment for selling</li> <li>➤ The equipment for renting</li> <li>➤ Services of giving classes</li> <li>➤ Services of food and drink supply</li> <li>➤ Services of tourists accommodation</li> <li>➤ Cultural and educational programs</li> <li>➤ Clean solar energy</li> </ul>	<p>4.Customer Relationship:</p> <ul style="list-style-type: none"> <li>➤ Direct personal relationships face to face</li> <li>➤ e-mail communication</li> <li>➤ Deep and intimate relationship built during 24 hours living together in the extreme meteorological conditions</li> <li>➤ Automatic services is allowed to old costumers (within the agreed equipment in the store, during high season)</li> <li>➤ Through different tourist and sport communities</li> <li>➤ By writing blogs and putting photos and videos on YouTube</li> </ul>	<p>1. Customer Segments:</p> <ul style="list-style-type: none"> <li>➤ Foreign tourist groups</li> <li>➤ Tourist groups from the country</li> <li>➤ Jung athletes from different sports</li> <li>➤ Kite fans</li> <li>➤ Windsurf fans</li> <li>➤ Different adrenalin water sport fans</li> </ul>
<p>6.Key Resources:</p> <ul style="list-style-type: none"> <li>➤ Human resources</li> <li>➤ Financial resources</li> <li>➤ New equipment (produced in actual year)</li> <li>➤ Specific location on the river mouth</li> <li>➤ Location in the sandy see beach</li> <li>➤ Wooden lodges</li> </ul>		<p>3.Channels of distribution:</p> <ul style="list-style-type: none"> <li>➤ Internet web site</li> <li>➤ Face book</li> <li>➤ Tourist agencies advertisements</li> <li>➤ Personal and group transfer of information</li> <li>➤ Channels of partners companies</li> <li>➤ Vehicle fleet</li> </ul>		
<p>9.Cost Structure:</p> <ul style="list-style-type: none"> <li>➤ Annual rental of the space</li> <li>➤ Taxes</li> <li>➤ Salary Fund</li> <li>➤ Procurement and purchase of new equipment</li> <li>➤ Energy costs</li> <li>➤ Food and drink costs</li> </ul>			<p>5.Revenue Streams:</p> <ul style="list-style-type: none"> <li>➤ Cash money</li> <li>➤ Negotiation</li> <li>➤ Selling of the value</li> <li>➤ Subscription</li> <li>➤ Renting</li> <li>➤ Licensing</li> </ul>	

SWOT analysis is an important part of the research, because it allows the organization to re-examine both itself and its environment, in order to understand past and present successes and failures, and in the intent to position itself for further progress. For this reason, the SWOT analysis was used to review the performance and development capabilities of Dragonproject CO, when the company is viewed as a business system in the profit market.

### 3.6. Results of the survey questionnaire on the topic of multidisciplinary approach in Dragonproject CO

Dragonproject CO has always had a strategy to expand the range of offerings and develop its strategy and organization in the context of multidisciplinary approach. This research confirms the correctness of the strategy chosen. By the method of questionnaire conducted among tourists, it was established that the multidisciplinary concept is what brings tourists to the Dragonproject CO Tourism Centre, so it can be claimed with certainty that Dragonproject CO will seek further organizational improvements through the multidisciplinary strategic and situational approach initiated.

A sample of 84 respondents answered a questionnaire with 10 questions, as shown in Appendix A at the end of this paper. The age structure of clients shows that the most frequent tourists are 20-30 years old (Table 2), which is logical, since this is the age when they are studying or are employed, and still young, with less family obligations and dealing with sports. The educational structure is shown in Table 3. The majority of clients are college-educated, which in fact represents a highly intellectual environment. Note that faculty education is attributed to students of the third and fourth year of faculty. The representation of women is 37% compared to 63% of men.

Table 2. Age structure of clients

Age	Number of clients
< 15	1
15 – 20	7
20 - 25	24
25 – 30	20
30 - 35	15
35 – 40	11
40 - 45	4
> 45	2
$\Sigma$	84

Table 3. Educational structure

Education	Number of clients
Elementary	1
Medium	4
Faculty	71
Master	5
Doctorate	3

The key and highly indicative results of the survey show that 82%, i.e. 97.6% of clients visited this tourist centre due to multidisciplinary approach to the organization, which definitely shows that multidisciplinary approach should remain and become a permanent development strategy for Dragonproject CO.

100% of respondents think that this tourist centre is different from others and that a multidisciplinary offers differs this centre from others. Namely, the content is designed in such way that when there is no wind, when clients cannot sail, the centre offers very attractive educational workshops, cultural entertainment and excellent organization in terms of environmental protection.

61%, i.e. 72.6% of tourists are old guests. 83%, i.e. 98.8% said they wanted to come back next year, precisely because of the broad spectrum of multidisciplinary programs, so definitely Dragonproject CO should keep the focus of its business strategies and organization on multidisciplinary approach.

The most prominent rank shows that the tourists value disciplines as per next order:

- multidisciplinary (all disciplines)
- sport
- fun
- culture
- education
- ecology
- solar power-plant

The main contribution of this paper is in testing of the presence and proving of the importance of multidisciplinary approach to the strategy and organization in one sea tourist centre as a demonstrative case study. As a result, this multidisciplinary model is applicable and feasible in mountain tourism and wider areas, which could be the subject of our next research.

## 4. CONCLUSION

Within this paper, a multidisciplinary approach to strategy and business system organization was analyzed and improvements were sought for Dragonproject CO from the range of multidisciplinary offers and activities from the nomenclature of work in domains of tourism, economics, education, sports, health, psychology and culture.

It is recommended that the improvement of Dragonproject CO business is sought within the synergy of strategic and situational approach to the organization, due to specificity of activities and location itself. The company is one of the few that realizes sustainable profitability, due to the concern about quality of environment and especially implementation of renewable energy sources and defined business goals. The guests are given the opportunity to participate in educational seminars on the importance of environmental protection and to get acquainted with the work of the mini solar power plant.

A survey of Dragonproject CO business model, done with an analogue Osterwalder and Pigneur organization model indicates that Dragonproject CO is currently well positioned on the market, as well as with additional business improvement space, because due to increased number of competing foreign centres at the same location, this should be analyzed in the context of exiting the “Blue Ocean” and entering the “Red Ocean”.

Within the analysis of development strategy and Dragonproject CO business system organization and in addition to the synergy of adequate multidisciplinary approach to strategic and situational organization system, the BMP model was developed, the SWOT analysis and survey among tourists conducted.

The goal was to research and try to answer the question how to maintain specific identity of tourist centre in Ada Bojana, and again have enough customers to enable the company to survive and have sustainable profitability. The answer is that a multidisciplinary approach to strategy and organization is what ensures long-term sustainable profitability.

It is recommended to retain and intensify the multidisciplinary approach to strategy and organization. The future development and improvement of Dragonproject CO business can also be sought in cooperation with foreign travel agencies, both at existing locations and with the extension to lakes and rivers in Serbia.

At the same time, additional observation and research of similar operation of schools abroad is needed, which are located in both attractive tourist zones and near metropolises, such as Belgrade, where there are both water resources suitable for intended purposes, and a large number of interested clients.

Further research may also be directed to mapping multidisciplinary model from marine to mountain tourism, for which appropriate field research has already been carried out, which began with testing the benefits of Kopaonik slopes for snow or grass kite.

This paper does not conclude the research topic, but opens up a wide range of opportunities for further researches in order to improve the performance of Dragonproject CO as a business system.

Dragonproject CO can certainly represent a generator of advanced ideas in the future and be a sustainability incubator, in the context of spreading experience of modern organization of a sustainable business system, as a synergy of a multidisciplinary strategic and situational approach and to be a cluster in economic terms.

#### APPENDIX A

How old are You?		
Education:		
1. Primary school		
2. Secondary school		
3. Faculty		
4. Master		
5. Doctorate		
Gender	M	F
You come in this tourist centre because of the:		
1. Sport		
2. Fun		
3. Cultural events		
4. Educational events		
5. Clean environment		
6. To see the mini-solar-powerplant		
7. All disciplines		
How would you rank the previous?		
Is this tourist centre different from the others?		
What makes this tourist centre different?		
Have you come to this tourist centre before?		
Will you come back here next year?		
Your comment relating to the organization of the tourist centre.		

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# STOCK MARKET VOLATILITY IN SOME SELECTED COUNTRIES – A THERMODYNAMIC APPROACH

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**Abstract.** *Volatility is an important concept in the theory of finance. Substantial changes in volatility of financial market returns are capable of having significant negative effects on risk-averse investors. Volatility can also have effect on consumption patterns, macroeconomic variables, etc. Traditionally the volatility has been addressed based on the concept of standard deviation approach and on the basis of the standard deviation approach ARCH, GARCH, EGARCH have been developed. Volatility is often used to describe dispersion from an expected value. As a measure of uncertainty and risk standard-deviation is very popular since it is simple and easy to calculate. But it is not fully satisfactory. It is severely affected by extreme values.*

*In this paper the concept of entropy basically developed in Physics by Clausius in 1855 will be used as an effective alternative. There is several measures of entropy. In this article we focused on the potentialities of Shannon entropy and Tsallis entropy. In this article the volatility of ten indexes has been examined. From the investigation it has found that KOSPI Composite Index (South Korea) attained the highest level of volatility and the immediate next one is TSEC weighted index (Taiwan).*

**Keywords:** *entropy, Shannon entropy, Tsallis entropy, volatility.*

## 1. INTRODUCTION

The concept of volatility in financial markets refers to the degree of unpredictable fluctuations of a process over time. Volatility can be used as a criterion to study the risk associated with a financial asset. Different statistical approaches used to measure volatility are summarized in the paper written by Henning, B.; Sloane, M.; de Leon, M. In that paper, the authors state that “price volatility is not a precisely or easily defined term. One consequence is that there are a variety of ways of measuring price volatility, depending on the elements of volatility that are considered critical”.

In literature, several historical volatility studies have been carried out on various markets. For instance, in the article written by Benini, M.; Marracci, M.; Pelacchi, P.; Venturini, A. showed that

volatility analysis was included for the Spanish, Californian, UK and PJM electricity markets. Li, Y.; Flynn, P.C. examined and compared the volatility of 14 deregulated markets through the “price velocity” measure (the daily average of the absolute value of price change per hour). Simonsen, I. studied some volatility features (volatility clustering, log-normal distribution and long-range correlations) of the Nordic day ahead power spot market, and it also pointed out that power

markets have greater volatility levels than other financial markets (stock indices, crude oil, natural gas...).

These studies were carried out using different measures of volatility. Most of them involve computing the standard deviation of: (1) the price series, (2) the arithmetic return over a time period  $h$ , or (3) the logarithmic return over a time period  $h$ . The value  $h = 1$  is the commonly used time period.

The main contribution of this paper is to compare two different approaches: one based on the statistical measure of the standard deviation or variance and the other one centered on the concept of entropy. In this regard, we particularly focus on the concept of Tsallis entropy, which constitutes a possible generalization of the Boltzmann-Gibbs or Shannon entropy. These measures were both generated in the domain of physics, although the latter is also attributed to the Information Theory, and their application to financial phenomena falls in the domain of the so-called econophysics. As Mantegna R N and Stanley H E pointed out an active domain of research in physics is the characterization of the process of prices changes, *i.e.*, volatility. In our particular investigation we apply the concept of entropy to capture the presence of nonlinear dynamics in stock market indexes since the standard deviation evidence some limitations. The empirical analysis is conducted with data from different countries for comparative purposes.

The article consists of a part that describes the most commonly used measure of volatility – the standard deviation. Next part presents two different measures of entropy: the Shannon entropy and a possible generalization of it – the Tsallis entropy. The next part exhibits the empirical findings and the last part draws the conclusions.

## 2. ABOUT THERMODYNAMICS

Thermodynamics is a branch of natural science that studies the effects of changes in temperature, pressure, and volume on physical systems at a macroscopic level and, most importantly, the relation of heat with energy and work. Lord Kelvin, one of the fathers of thermodynamics, defined it in 1854. The keystones of thermodynamics are its four universal laws:

### ZERO LAW OF THERMODYNAMICS

If two systems (A and B) are each in thermal equilibrium with a third one (C), they are also in thermal equilibrium with each other. Mathematically, the law relates systems A, B and C as follows

if  $T(A) = T(B)$ , and  
if  $T(B) = T(C)$ , then  
 $T(A) = T(C)$

where  $T$  is the temperature of the systems.

## FIRST LAW OF THERMODYNAMICS

The increase in internal energy ( $\Delta U$ ) of a closed system is equal to the difference of the heat ( $Q$ ) supplied to the system and the work ( $W$ ) done by it:

$$\Delta U = Q - W \quad (1)$$

Heat may be absorbed by the system from a source at a higher temperature or transferred to a system at a lower temperature; conversely, work may be performed by the system or its surroundings. The differential expression

$$dU = \delta Q - \delta W \quad (2)$$

where  $d$  and  $\delta$  denote infinitesimal change in the variables

## SECOND LAW OF THERMODYNAMICS

Heat cannot spontaneously flow from a colder location to a hotter location. Alternatively, it is not possible to change heat completely into work.

## THIRD LAW OF THERMODYNAMICS

As a system approaches absolute zero (0K, or  $-273.15^\circ\text{C}$ ), the entropy of the system approaches a minimum value.

Second law of Thermodynamics states that nature tends to move towards most probable state. It is nothing but a statistical law.

Maximum internal states possible without any apparent change in external state.

Entropy =  $S = K \log W$  [Entropy is a macroscopic variable]

Where,  $K \Rightarrow$  Boltzmann's constant

$W \Rightarrow$  number of ways internal states possible without any apparent change in external state.

Entropy will be maximum when  $W$  will be maximum.  $W$  will be maximum at most probable state.

Entropy always increases. It means that nature moves towards most probable state.

## 3. VARIOUS MEASURES OF VOLATILITY

At first we will keep some light on the standard deviation and then analyze the Tsallis entropy and a special case of it – the Shannon entropy. It is well known to us that volatility is popular as a synonymous of risk and uncertainty. Volatility could be not constant over time.

A traditional way of measuring volatility is to compute the returns  $r_t$  of an asset:

$$r_t = \log P_t - \log P_{t-1}$$

where  $P_t$  denotes the prices at time  $t$  and  $P_{t-1}$  denotes the prices at time  $t-1$ .

Formula for standard deviation is as follows:

$$\hat{\sigma} = \sqrt{\frac{\sum_{t=1}^T (r_t - \bar{r})^2}{T-1}} \quad (3)$$

where  $\bar{r}$  (sample average return) =  $\frac{\sum r_t}{T}$ .

This gauge is simple to estimate, but it has some drawbacks. It could lead to an unexpected change in volatility once shocks fall out of the measurement sample. It only captures linear relationships; it ignores all kind of nonlinear dynamics among data. So to understand the concept of volatility more sophisticated measures are needed. The concept of entropy is a new measure to capture nonlinear dynamics among data. The main focus of this paper is to capture the volatility in some stock markets by using entropy.

Though there are number of imperfections or disadvantages in the standard deviation still it is a accepted measure of volatility for forecasting of more complex model.

## THE CONCEPT OF ENTROPY

An alternative way to study stock market volatility is by applying concept of entropy of physics. In a subsequent investigation Shannon provided a new insight into this matter showing that entropy wasn't only restricted to thermodynamics but could instead be applied in any context where probabilities can be defined.

For a given a probability distribution  $p_i$  equivalent to  $p(X = i)$ , ( $i = 1, \dots, n$ ) of a given random variable  $X$ ,

$$S(X) = -\sum_{i=1}^n p_i \log p_i \quad (4)$$

Shannon entropy has been most successful in the treatment of equilibrium systems in which short or temporal interactions with ergodicity and independence dominate. However, there are many irregular systems in nature that do not verify the simplifying assumption of ergodicity and independence. To overcome this kind of weakness Tsallis drawn a new measure of entropy and that is Tsallis entropy.

Following is the Tsallis entropy:

$$S_q(X) = \frac{k}{q-1} (1 - \sum_{i=1}^n p_i^q) \quad (5)$$

Given a discrete set of probabilities  $p_i$  with the condition  $\sum_i p_i = 1$  and  $q$  any non-negative real number considering the probability distribution  $p_i$  equivalent to  $p(X = i)$ , ( $i = 1, \dots, n$ ) of a given random variable  $X$ , Tsallis entropy  $S_q(X)$  is shown above. Here  $q$  is a real parameter sometimes called *entropic-index*. In the limit as  $q \rightarrow 1$ , the usual Boltzmann–Gibbs entropy is recovered. The number of  $q \in R$  is an entropic index that characterizes the degree of non-extensivity of the system. It is used to describe system with non-extensive properties, and it is also used to characterize the non-extensivity degree of particular system.

Given two independent systems A and B, for which the joint probability density satisfies

$$p(A, B) = p(A)p(B) \quad (6)$$

the Tsallis entropy of this system satisfies

$$S_q(A, B) = S_q(A) + S_q(B) + (1 - q)S_q(A)S_q(B) \quad (7)$$

From this result, it is evident that the parameter  $|1-q|$  is a measure of the departure from additivity. In the limit when  $q=1$

$$S_q(A, B) = S_q(A) + S_q(B) \quad (8)$$

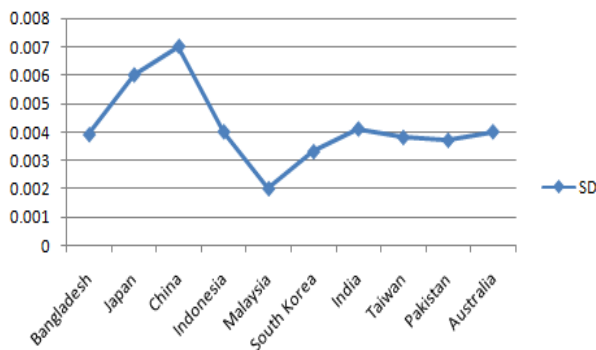
which is what is expected for an additive system. This property is sometimes referred to as “pseudo-additivity”.

#### 4. OBJECTIVE

The objective of my paper is to detect the variation of volatility among different countries using entropy. It is relevant in the context of globalization.

#### 5. DATA

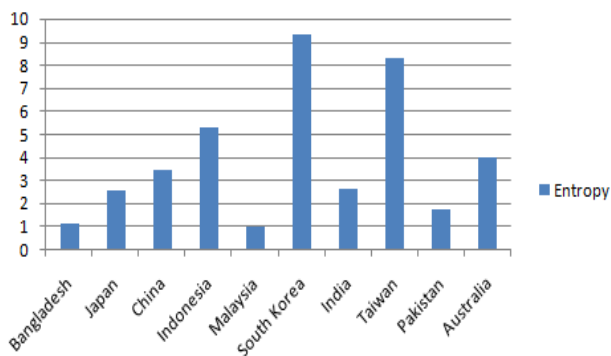
Daily returns of Dhaka Stock Exchange (Bangladesh), JPX-Nikkei 400 (Japan), Shenzhen Stock Exchange (China), Jakarta Composite Index (Indonesia), FTSE Malaysia KLCI (Malaysia), KOSPI Composite Index (South Korea), S&P BSE SENSEX (India), TSEC weighted index (Taiwan), Karachi 100(Pakistan) and S&P/ASX 200 (AXJO (Australia) over the period of study (5<sup>th</sup> August, 2014 to 29<sup>th</sup> December, 2016) are considered for the empirical research. These data were collected on daily basis. Official website is <http://www.site-by-site.com/asia/indo/stocksin.htm>. Closing price were the inputs.



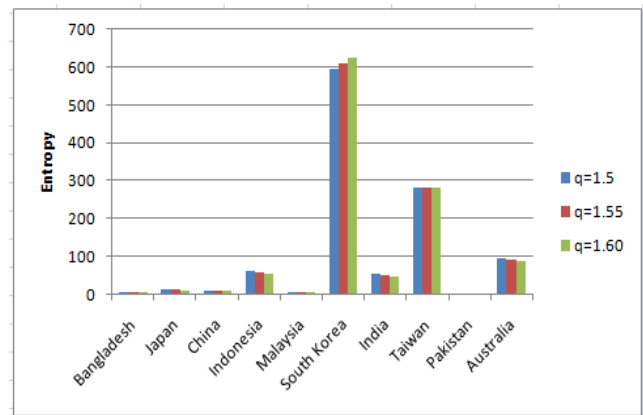
**Fig. 1** depicts Standard deviation of stock index returns for indices. It was observed from the ten stock markets that Shenzhen Stock Exchange (China) has the higher volatility indexes and the immediate next one is JPX-Nikkei 400 (Japan). The ranking also gives us an idea about that all values are close to zero which may suggest that all of them show signs of low volatility in spite of their particular values. It is well known to us that standard deviations of stock markets are influenced by abnormally high observations and are not able to capture nonlinear dynamics.

#### 6. RESULTS OF ENTROPY

The computed results of Shannon entropies are represented in figure 2.



The computed results of Tsallis Entropy of stock index returns is represented in figure 3.



All entropies were estimated with histograms based on equidistant cells. For the calculation of Tsallis entropy we have set values at 1.5, 1.55 and 1.6 for the index  $q$ , which is consistent with the finding that when considering financial data their values lie within the range 1.5-1.6. It is worthy to note that KOSPI Composite Index (South Korea) attained the highest levels of volatility and the immediate next one is TSEC weighted index (Taiwan). In the overall, it appears that the use of entropy as a measure of uncertainty allows better insights over the identification of volatile markets, by distinguishing them more sharply, than simply using the standard deviation. This leads us to the conclusion that entropy is more general and better suited for describing stock market volatility. Entropy can be computed from metric and non-metric data. Apart from that the major advantages of entropy when compared to the standard deviation can be summed up as follows:

- (i) it integrates much more information than the standard deviation;
- (ii) it has no distribution. It means that it is not dependent upon any particular distribution; it avoids the introduction of errors through the fitting of the distribution of returns to a normal-like distribution.
- (iii) Since entropy is independent of the mean for all types of distributions, it satisfies the first order conditions and
- (iv) due to its common comprehending of mean uncertainty, it also serves as a measure of dispersion.

On the other hand, some shortcomings have also to be weighted when considering the use of any kind of entropy. First one has to do with its inbuilt complexity when compared to the simple standard deviation. Second, is related to the amount of statistical bias in these measures due to the degrees of freedom allowed in an experiment.

#### 7. CONCLUSION

In this article the volatility of ten indexes has been examined. Ten indices are Dhaka Stock Exchange (Bangladesh), JPX-Nikkei 400 (Japan), Shenzhen Stock Exchange (China), Jakarta Composite Index (Indonesia), FTSE Malaysia KLCI (Malaysia), KOSPI Composite Index (South Korea), S&P BSE SENSEX (India), TSEC weighted index (Taiwan), Karachi



100(Pakistan) and S&P/ASX 200 (AXJO (Australia). The main goal was to compare two different viewpoints.

- (i) based on the standard deviation and
- (ii) based on the concept of entropy (the Tsallis and the Shannon entropies).

In particular, the results from both entropies have shown nonlinear dynamics in the volatility of all indexes. However, most of the outcomes are not in accordance with the statistics produced by the standard deviation, which emphasizes that this method is not able to capture the overall behaviour of dispersion. This is especially relevant for the decision making process in which all the information is regarded as necessary and useful. It has found that KOSPI Composite Index (South Korea) attained the highest level of volatility and the immediate next one is TSEC weighted index (Taiwan). Since entropy can capture the uncertainty and disorder in a time series without imposing any constraints on the theoretical probability distribution in this paper has addressed the concept of entropy.

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# ASPECTS OF STRESS MANIFESTATION IN LANGUAGE TEACHING AND LEARNING

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**Abstract.** *As numerous neuroscientific researches demonstrate the complex and highly paradoxical action of stress on the learning and teaching process, the author, who is a teacher of English as a foreign language himself, considered a few significant aspects of this intricate bilateral action. Setting out from a number of remarks in the literature, as well as his own observations, he presented some (hopefully effective) possibilities for (bad) stress to be turned into the positive/good variant of stress (which can be termed eustress). Some of the main adequate ways that TEFLs can adopt in this country include the communicative type of teaching (CT), essentially based on genuinely motivating the students.*

**Key words:** *stress, positive stress, learning and teaching foreign languages, EFL, motivation, communicative approaches.*

## 1. INTRODUCTION

A lot of research has been conducted into stress over the last hundred years. Some of the theories behind it are now settled and accepted; others are still being researched and debated. During this time, there seems to have been something approaching open warfare between competing theories and definitions; views have been passionately held and aggressively defended. What complicates this is that intuitively we all feel that we know what stress is, as it is something we have all experienced. A definition should therefore be obvious... except that it is not.

Hans Selye was one of the founding fathers of stress research. His view in 1956 was that "stress is not necessarily something bad – it all depends on how you take it. The stress of exhilarating, creative successful work is beneficial, while that of failure, humiliation or infection is detrimental". Selye believed that the biochemical effects of stress would be experienced irrespective of whether the situation was positive or negative. Since then, a great deal of further research has been conducted, and ideas have moved on. Stress is now viewed as a "bad thing", with a range of harmful biochemical and long-term effects, which have rarely been observed in positive situations.

2. Nowadays the most commonly accepted definition of stress (the definition which is mainly attributed to Richard S. Lazarus) is that *stress is a condition or feeling experienced when a person perceives that "demands exceed the personal and social resources the individual is able to mobilize.* In short, it is what we feel when we think we have lost control of events. Still, we have to also recognize that there is a combined instinctive stress response to unexpected events. The stress response inside us is therefore part instinct, and part attributable to the manner in which we think. Stress can also come in the form of the world-wide famous (or maybe notorious?) phenomenon the Japanese are credited to have named (or else, generated), i.e. *karoshi*... exhaustion through too much working. (We may wonder what are some of the most

celebrated or widely respected Japanese proverbs or old saws illustrating this state of affairs, or work as a general notion)...

3. By far the best way of learning (and teaching) a foreign language is, in almost every educationalist's opinion today, language **immersion**. It is only fair to be so, because immersion gives you the possibility of having not only direct and relevant contact with the reality of the language being studied, in real-life surroundings and circumstances, but also continuous, repetitive, (culturally) genuine and massive contact with natural-sounding, structurally congruous and authentic language models and patterns. This is a complex (and also natural) situation, where, on the one hand, stress is generated, and, on the other hand, there is a noticeably strong tendency towards facilitating language use through linguistic *exposure*. In a way, it is quite easy to understand that getting accustomed with oddity and incongruity (which is the very source of stress) means getting used to that stress, which in turn means (partial) alleviation of stress! Hence, immersion and exposure *are* stress, but they are demonstrably (and dialectically) illustrative of what is usually called *positive stress*, which can be one of the efficient tools pertinent for the language teacher in his/her interaction with the class of students.

4. Likewise, learning and teaching by means of (longer or shorter) *chunks* of language is one of the ideal methods available for the foreign language teacher. It is true that it can create a fair amount of stress, particularly in the initial stage(s) of the process of learning-and-teaching, because we deal with rather long (or, at any rate, rather unwieldy fragments, which are naturally harder to memorize), but it will eventually turn out to be a most rewarding approach, since it is able to reduce some of the stress related to memorizing and remembering the many various jumbled, disparate, (apparently) cross-purpose language items, be they shorter (mainly words, with all their idiosyncrasies) or longer (typically phrases and syntactic structures), or usage and combinational issues (collocability / collocation, grammatical regimen semantic-syntactic and restrictions, etc.), which actually engenders further stress. In such a way, one can convincingly that some of the fundamental stress associated with learning and teaching a foreign language can be mitigated: i.e. the deep-seated tension holding between the speaker's main targets – *accuracy* vs. *fluency*.

However, *immersion* (etymologically) also implies the danger of *drowning*. (Currently, the term is used as a synonym for *engagement, concentration, interest, fascination and raptness*, but its original root is the same as that of *submerge* – compare also with related phrases like *to be engrossed* or *absorbed into something*) For the learner not to be *submerged* by the deterring, distracting multitude of odd, strange (compare with the related term *stranger*), unnatural (!) elements involved in the messages couched in the target-language – from phonetics, semantics and grammar structures, to cultural and stylistic implications, which exposure to the foreign language naturally and massively generates (all the more as it is more dissimilar

in point of typology from the source-language e.g. Japanese vs. Romanian, as compared with Italian vs. Romanian), the learner will have to be helped along in managing his/her learning process and/or programme. This can be effectively done through short steps, creating and maintaining a certain type of incorporable logic (or substitutive logicality, so to speak, as this is not necessarily a really *logical* logic), as well as a set of user-friendly learning-and-teaching procedures, which can facilitate progress and, at the same time, (seem to) bridge the linguistic gap without (major) pains and hitches. So the teacher has to be the main source in providing the learner with the much needed mediation.

5. Having established that stress is both a hindrance and a motivation element, we should be interested in noting some of the effects and implications of stress as far as didactic theory and practice are concerned. In relation to challenge and hindrance stress – i.e. relationships with exhaustion, motivation to learn, and learning performance – authors LePine and Jackson (*Journal of Applied Psychology*, vol. 89(5), Oct. 2004, pp. 883-891) found that stress associated with challenges in the learning environment had a positive relationship with the learning performance (of the 696 learners surveyed), and that stress associated with hindrances in the learning environment had a negative relationship with learning performance. They also found evidence suggesting that these stress-learning performance relationships were partially mediated by exhaustion and motivation to learn. Both forms of stress were positively related to exhaustion, and exhaustion was negatively related to learning performance. Hindrance stress was negatively related to motivation to learn, challenge stress was positively related to motivation to learn, and motivation to learn was positively related to learning performance.

Most research suggests that there is *fight or flight* reaction (cf. the results of Walter Cannon's 1932 research on stress, which established the existence of the 'fight-or-flight' response: an organism experiences a shock or perceives a threat, it quickly releases hormones that help it to survive), which may be useful in some situations, but it is highly detrimental in the classroom. Whether anxiety stems from test taking or from an unstable home environment, the brains of students experiencing high levels of stress look different than those who are not – and those brains behave differently, too. Let us now take a look at the neural and hormonal responses that underpin a student's stress response, so as we can make a few tentative suggestions for continuing to teach through the challenges it presents.

The body and the brain respond to stress with a complex cascade of hormones and neurotransmitters. When a child's senses perceive danger, their hypothalamic-pituitary-adrenal (HPA) system releases steroid hormones (glucocorticoids). This includes the primary stress hormone, cortisol, which has a direct effect on the heart, lungs, circulation, metabolism, immune system and skin. The HPA also stimulates the release of catecholamine neurotransmitters like dopamine, norepinephrine and epinephrine (adrenaline), which activates the *amygdala* (part of the limbic system in the temporal lobe), which in turn triggers a response of apprehension. The brain then releases neuropeptide S, which increases alertness and feelings of anxiety.

Together, the HPA system will keep a child's stimulated and ready to run. But while this may be good for truly life or death situations, this stress response makes learning difficult, as the

stimulated senses are not those associated with deep learning. Let us consider this situation: would you be able to memorize the multiplication table when you were being chased by a bear?

The answer is, naturally, *no*. But while this may be obvious, the reasons why this is the case is more complex than one might expect.

6. In the short term, acute stress prevents memory storage. According to a 2008 study by University of California Irvine researchers, when cortisol reaches the hippocampus, the brain's primary structure for consolidating information from short term into long term memory, the structure's dendritic spines disintegrate rapidly. Learning and memory storage takes place effectively when neurons are constantly and repetitively activated across their synapses – a process that effectively tells the brain that a stimulus, behavior or habit is important to retain. When dendritic spines disintegrate, the brain's capability of identifying and storing significant information is greatly inhibited. As it happens, dendritic spines can grow back (though in the long term, their loss may actually reduce the hippocampus). Basically, the brain learns how to stay stressed or to rapidly intensify its function up to a stress response. This occurs very much like any other type of learning: even very simple addition or subtraction drills can turn a person's thought process from a rather complicated to a comparatively more efficient (possibly even instantaneous) operation.

Specifically, executive functions like self-control, impulse control, memory, and reasoning – skills that are essential to successful learning. Some studies suggest that cortisol even has the ability to quickly generate a switch in stem cells so that they can actively inhibit the forming of new connections in the prefrontal cortex, while strengthening pathways that run between the amygdala and the hippocampus.

Of course, stress is bad for students of any age, in both its acute and chronic form. Nevertheless, the effects of stress are typically dangerous in early child development. Therefore, educators and didacticians at every level should take action against it. Here are some of the main paths conducive to success in learning and teaching: (1) Considering resilience and grit as higher human values. Indeed, rewiring the brain, just like persevering through skill mastery, requires determination, continual effort and pushing through perceived failures. Educators can teach this skill by creating lesson plans on grit and exploring the concept explicitly. (2) Actions that teachers can take to reduce anxiety in the classroom, e.g. encouraging self-awareness, teaching time management, giving As for effort, teaching mindfulness and meditation, providing exemptions for especially anxiety-inducing activities, etc.

7. The neuroscientific research about learning has revealed the negative impact of stress and anxiety and the qualitative improvement of the brain circuits involved in memory and executive function that accompanies positive motivation and engagement. The effects of positive motivation are both proven and efficient. This particular piece of information has led to the development of brain-compatible strategies to help students through the bleak terrain created by some of the current trends imposed by the current standards in EFL. Carefully chosen brain-based teaching strategies can drastically reduce classroom anxiety and increase student connection to their lessons, so educators can help students to learn both more effectively and more rapidly.

Such brain researches demonstrate that superior learning takes place when classroom experiences are really motivating and engaging. Positive motivation visibly influences brain metabolism, conduction of nerve impulses through the memory areas, and the release of neurotransmitters that increase executive function and attention. Relevant lessons help students to feel that they are partners in their education, and so they became engaged and motivated. We live in a stressful world and in troubled times, which can hardly be considered the normal way for children to grow up. Schools can be the safe sanctuary where academic practices and classroom strategies provide children with emotional comfort and pleasure as well as knowledge. When teachers use strategies to reduce stress and build a positive emotional environment, students gain emotional resilience and learn more efficiently and at higher levels of cognition.

8. Implementing the so-called *communicative* method should amount to having a communicative, stressless, rather than a communicative *and* stressful scheme. Exercising with the drills, language chunks, real-life-like reactions to real-life-like stimuli, functional interaction, etc. should add up to something very similar to play – a kind of serious play, though.

Native-like, or near-native-like **fluency** is a very interesting case in point, in this context. Such opinions can be heard all over the world, coming from students of language, teachers, or former learners who are now (more or less) proficient in speaking a given foreign language: “I have heard that regardless of where you live (language spoken) if you are a foreigner you will always count, pray and curse using your native language. And, of course... dream!”; or “The more interesting thing of being truly fluent bilingually is that I sometimes don’t remember what language I had a particular conversation in. What I mean by that is when I touch on a topic, I might remember a specific story about it being told by someone I had a conversation with a while ago. If I don’t remember exactly who told me the story, chances are I’ll struggle to remember if an English friend of mine or a Chinese friend of mine told me that story. I’d try to replay that conversation in my head, and both the Chinese version and the English version seemed just as likely to have happened, because my brain processed the story without a specific language and remembered the story only instead”.

The closest we as FL teachers can come to implementing a learning-efficient environment in the classroom seems to be the use of the so-called communicative method (or approach). Jack C. Richards (2006) gives the following succinct hints about this approach: (1) People learn a language through communicating in it. (2) People learn a language best when using it to do things rather than through studying how language works and practicing rules. (3) Classroom activities should be meaningful and involve real communication. (4) CLT is usually described as a method of teaching. On the other hand, using and praising this approach (and teaching method) should not make one overdo the strengths of the approach and erroneously think that: (1) CLT is only concerned with teaching speaking. (2) Grammar is no longer important in language teaching. (3) Errors are not important in speaking a language. (4) Dialogues are not used in CLT. (5) The main goal of CLT is fluency (vs. accuracy). By and large, communicative language teaching can be understood as a set of principles about the goals of language teaching, how learners learn a language, the kinds of classroom activities that best facilitate learning, and the roles of teachers

and learners in the classroom. Thus, the main goals of language teaching are related to the teaching of *communicative competence* (vs. *linguistic competence*).

Actually, in more recent years, language learning has been viewed from a very different perspective. It is seen as resulting from processes such as: ● Interaction between the learner and users of the language ● Collaborative creation of meaning ● Creating meaningful and purposeful interaction through language ● Negotiation of meaning as the learner and his or her interlocutor arrive at understanding ● Learning through attending to the feedback learners get when they use the language ● Paying attention to the language one hears (the input) and trying to incorporate new forms into one’s developing communicative competence ● Trying out and experimenting with different ways of saying things.

9. In the context of the teacher’s contribution to making it easier and more unstressful to learn a foreign language, the communicative approach to language teaching can be considered as an excellent case in point (the following considerations are mainly based on William Littlewood’s 2000 book *Communicative Language Teaching*). Thus, these actions, standards and general considerations must be paid attention to in order to effectively help students: ● Choosing what to teach (choosing course-content); ● Predicting communicative needs: The Council of Europe’s ‘Threshold Level’: (a) the most important communicative needs that are likely to arise in everyday situations, (b) suitable language forms that could be learnt for coping with these needs.

The teacher may find himself/herself in the situation to answer the following in order to predict communicative needs: 1. what situations might the learner encounter? 2. what language activities is the learner most likely to take part in? 3. what functions of language are likely to be most useful? 4. what topics are likely to be crucially important? 5. what general notions are likely to be (more, or specifically) important? 6. what language forms should the student learn, in order to satisfy the communicative needs described? (The Threshold Level lists these under three main headings: ● forms which express communicative functions (mostly grammatical patterns); ● forms which express general notions (grammatical patterns and items of vocabulary); ● forms which express topic-related notions – mostly items of vocabulary).

The teacher should consider a balance between the focus on form, and the focus on meaning. There should be a varying degree to which the different activities encourage learners to focus on (a) linguistic forms to be practised, or (b) meanings to be conveyed. In our everyday language use we normally focus our attention primarily on the meaning of what we say or hear, rather than on its linguistic form. From this perspective, we can define the goal of foreign language teaching in the following terms: to extend the range of communication situations in which the learner can perform with focus and meaning, without being hindered by the attention he/she must pay to linguistic form.

The following categories of activities will be typically considered: (1) Pre-communicative activities aim to give the learners fluent control over linguistic forms, so that the lower-level processes will be capable of unfolding automatically in response to higher-level decisions on meanings. Although the activities may emphasize the links between forms and meanings, the main criterion for success is whether the learner produces acceptable language. (2) In communicative activities,

the production of linguistic forms becomes subordinate to higher-level decisions, related to the communication of meanings. The learner is thus expected to increase his/her skill in starting from an intended meaning, selecting suitable language forms from his/her own total list, and producing them fluently. The criterion for success is whether the meaning is conveyed effectively.

There are situations when the learner is required both to use structures specified by the teacher, and to communicate meanings for a purpose. In such activities, the focus might be equally distributed between the forms to be produced and the meanings to be conveyed. The teacher may reinforce this twofold focus not only through his/her preparation and presentation of the activity, but also through the feedback he/she provides in response to the learners' performance.

If the purpose is to produce certain pre-determined linguistic structures, success will be measured according to corresponding structural criteria, namely: how accurately and/or fluently the structures are produced. If the purpose is to convey or comprehend meanings, success will be measured according to communicative criteria, namely how *effectively* communicative takes place.

Likewise, feedback may focus on the level of form and/or meaning. If the teacher consistently corrects linguistic forms, this indicates that success is now being measured by formal criteria, and that the learner should therefore focus his/her attention on the production of correct linguistic forms. When a teacher wants his/her learners to focus on the effective communication of meanings, he/she must reinforce this focus by providing them with feedback about how successful communication has been (indicated by the task in itself).

It is important for the teacher to monitor the type of feedback that his/her learners receive, so that it supports the methodological purpose of the activity. For example, in pre-communicative activities, he/she will need to provide feedback related to linguistic form, which does not exclude communicative feedback. For example, while he/she is drilling a new structure through question-and-answer practice, a teacher may react to the meanings of the learners' responses as well as to their formal accuracy. This can help to create the illusion of a 'communicative' exchange and thus reinforce the links between structure and meaning. In communicative activities, the teacher will need to provide communicative feedback, which does not necessarily exclude structural feedback altogether. However, the teacher must be aware that excessive correction will encourage learners to shift their attention from meanings to forms.

10. Significantly, the role of the teacher is a bit different in the communicative method. A teacher might decide not to correct errors that he/she observes. To many teachers, this might appear to conflict with their pedagogical role, which has traditionally required them to evaluate all learners' performance according to clearly defined criteria. Certainly, it suggests that a communicative approach involves the teacher in redefining, to some extent, this traditional role. Thus, the teacher may be: a general overseer of his/her students' learning; a classroom manager; a language instructor; an observer through independent activity (communicative activity); a consultant or advisor, helping where necessary; a communicator with the learners. Our own didactic activity and reflective writing (see also bibliography below) has presented us with numerous examples of effective dealing with the challenges, hitches and paradoxes of learning and teaching under stress.

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